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Child Behavior, Animal Behavior, and Comparative Psychology

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FORM DISCRIMINATION IN CHIMPANZEES AND TWO-YEAR-OLD CHILDREN: I FORM (TRIANGULARITY) *PER SE*[*1]

From the Laboratories of Comparative Psychobiology of Yale University

LOUIS W GELLERMANN

INTRODUCTION

Problems concerning "shape," "form," and "pattern" discrimination were discussed and defined in 1913-1914 by Hunter (9), Bingham (1, 2), and Washburn (14). Hunter raised the question of the influence upon the discrimination of form of the background upon which a figure appears (9) He pointed out the distinction between "form" and "pattern" Bingham suggested that there is a difference between the discrimination of "shape" due to "unequal stimulation of different parts of the retina" and of "form" *per se*, e.g, triangularity (2). Concerning this distinction Hunter stated, "Animals do not discriminate *form* in the abstract sense in which Bingham uses that term . I would go farther and present the hypothesis that *all* animals below man have only a more or less crude pattern vision and that this probably applies also to a varying period of human childhood" (9, p 330). Washburn in this connection said that in order to discriminate the "form" of triangles in Bingham's sense an animal must be "possessed of an abstract idea of triangularity" (14, p 320) Additional details of this discussion may be found in a summary by Munn (12).

In general, this discussion raised two related problems (1) the discrimination of *form per se*, and (2) the influence of *background* upon the descrimination of *form* Many of the studies of form discrimination have been concerned more with the problem of apparatus than with the issues described above Such studies contribute only indirectly to the present investigation A few studies,

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*Accepted for publication by Carl Murchison of the Editorial Board

[1]The experiments reported in this series were done at the suggestion and under the supervision of Professor Robert M Yerkes while the writer was a National Research Fellow in the Laboratories of Comparative Psychobiology at Yale University The actual experimental work was conducted daily from October 15, 1931, to June 15, 1932

however, have not only attacked the problems outlined above but have added to the definition of the problems involved. Munn and Stiening (13) have attacked the problems directly by studying in a 15-months-old child (1) the relative efficacy of form and background in the discrimination of visual patterns, and (2) the discrimination of form *per se*. Weidensall (15) demonstrated that in studies of this kind the efficacy of the *negative* as well as the *positive* stimulus must be determined. Fields (4) has placed special emphasis upon studying the effect upon form discrimination of the degree of *rotation* of figures. While the problems investigated in the present series of experiments are drawn in part from all the studies mentioned above they are most closely related to the recent work of Fields (4) and of Munn and Stiening (13)

The question naturally arises in connection with a study of form discrimination, "What is form *per se*?"

Investigations of the discrimination of "form *per se*" often have explained the term by means of the example, "Triangularity" This, however, does not offer the kind of answer to the question that is needed A study of the problem reveals that there is no accepted usage of the term in the literature.

In the absence of a definite statement elsewhere it was necessary to attempt to combine such suggestions as did exist into a working definition of the term In particular the question as applied to the present study was, "What behavior on the part of the subjects will demonstrate that they can respond to triangularity?" It was decided to use the following criteria of the discrimination of form (triangularity) *per se*:

1. A subject must be able to learn to discriminate a triangle from other forms
2. He must be able to maintain the discrimination throughout *rotation* of the triangle.
3. His discrimination must be independent of absolute or relative size.
4. He must be able to respond to *all types* of triangles, as well as to the particular one upon which he was trained.
5. He must be able to respond to *outlined* triangles as well as to solid figures
6. His discrimination of the triangle from other forms must be independent of the particular *backgrounds* in which the forms appeared

If a subject could satisfy these criteria the presumptive evidence would be that he could discriminate form *per se*

The experiment reported in the present paper sought to investigate the following problems, all related to the general problem of form discrimination

1 Can chimpanzees and two-year-old children discriminate form (triangularity) *per se*?[2]

2 What is the relative efficacy of the negative versus the positive stimuli in the discrimination of form by these subjects?

3 What are the verbal responses of the children in connection with the various aspects of the present problem situations? Do these verbal responses seem in any essential way associated with the discrimination of form in its various aspects?

In connection with these problems a variety of tests were conducted The nature of these tests and the way in which they were applied will be described in connection with the presentation of results

Apparatus

Figure 1 presents photographs showing the alternation box-apparatus used in the present experiment This is the same apparatus used by the writer in his study of double alternation with chimpanzees (7) The essential features of the apparatus may be briefly stated as follows Two small boxes with hinged lids were mounted 3 feet apart on a platform The box lids could be locked shut Food could be introduced underneath each of the boxes by means of a food carriage which ran on a track immediately beneath the box platform The experimenter sat behind a one-way vision screen about 12 feet from the boxes From this point he could control the action of the box lids by means of levers and determine which of the box lids should be unlocked by pulling one of two cords Also he could introduce new food between the boxes by simply turning a crank The starting-point for the subject was a chair located beside the experimenter's screen and directly before the box-apparatus The subject's task was to go from this point to the box-apparatus and open one of the two boxes, thereby securing food

To adapt the alternation box-apparatus to the needs of the form-

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[2]All aspects of the discrimination of form *per se* were studied in this paper except the influence of the background That problem is studied in the second paper of this series (5)

discrimination experiment a new type of form-presentation frame was constructed. This is shown in Figure 1. It consisted in a box-like frame 13 inches high, 36 inches wide, and 3 inches deep. On the front of this frame and 13 inches apart were two glass windows (10" by 10") through which the forms could be exposed. The whole form-presentation frame was firmly bolted to the box-apparatus platform just between and behind the two food boxes. The

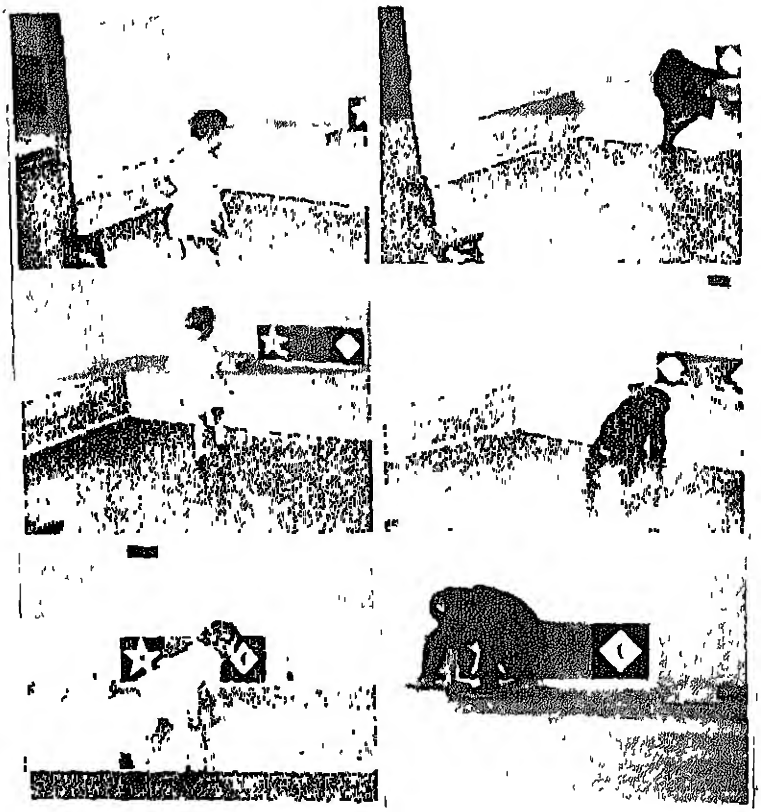

FIGURE 1

PHOTOGRAPHS SHOWING SUBJECTS IN THE EXPERIMENTAL SITUATION

The starting-chair and part of the experimenter's one-way vision screen appear on the left of the top photographs. The two food boxes and the form-presentation frame are shown in the bottom photographs. These pictures are enlargements from 16-mm cinema records.

actual forms which the subjects were required to discriminate were various combinations of cardboard placed behind the two windows of the form-presentation frame. A combination of two pieces of cardboard (11" by 11") were used to make each form. A white triangle on a black background was secured by cutting a triangular aperture in a piece of black cardboard and placing this cardboard in front of a white cardboard in the presentation frame. This procedure is similar to that used by Munn except that here white cardboard was used instead of opal flash glass. In order to change the forms from side to side only the front cards were moved. The back cards, usually of white, remained in place on the right and left. The panel separating the two windows was wide enough to serve as a screen behind which the form cards could be moved as they were changed from side to side. Also the space behind this panel provided a form card "magazine" in the center of the presentation apparatus. It was possible to secure all necessary form changes without taking cards out of or introducing new cards into the presentation frame during any series of trials.

Method

The subjects used were two two-year-old children and two young chimpanzees. The children were Jimmy, the son of a member of the Yale Medical School staff, and Nancy, the writer's daughter. Both were regular attendants in the Nursery School of the Clinic of Child Development of Yale University.[3] The chimpanzees were members of the primate colony of the Laboratories of Comparative Psychobiology at Yale: Moos, male, Number 11, estimated age 5 years; and Song, male, Number 7, estimated age 6 years. These are the same subjects used by the writer in a study of double alternation behavior of chimpanzees during the previous year (7).

Throughout the experiment identical procedures were used with all subjects in so far as possible. All subjects were given the same preliminary training in the apparatus room and with the apparatus itself. Every day for six weeks each subject was taken into the room and allowed to play about, becoming familiar with all parts of

[3]The writer is indebted to Dr. and Mrs. W. E. Callison who permitted the use of their son for this investigation. The writer is indebted also to Professor Arnold Gesell, Director of the Clinic of Child Development at Yale University, and to Dr. Margaret Washburn and Miss Jennings, Instructors in the Nursery School, for their kindly cooperation throughout the course of these experiments.

the room and apparatus. Throughout the course of the experiment, trials were conducted every morning at 11:00 o'clock It was felt that in this way the subjects would be reasonably hungry throughout their trials Food was used as reward for all subjects This consisted in bits of chocolate-covered cookie, banana, grapes, orange, and apple. In general, the chimpanzees appeared more effectively motivated than did the children.

At no time were any of the subjects given any verbal instructions in connection with the principal problem of the investigation, i.e., the response to form All verbal and gestural responses of the subjects were carefully recorded. The experimenter limited his talking with all subjects in the experimental situation to such statements as "Now sit on the chair, Moos" and other such directions connected with keeping the subjects on the starting-chair during the intervals between trials. Identical procedures were used with all subjects in this connection as in all others. The possible effect of simple verbal instructions on both children and chimpanzees has been commonly overlooked in most previous investigations. It has been an uncontrolled source of error

The daily routine for each subject was as follows: The subject was brought into the experimental room and seated in the starting-chair. On each trial the subject was to go to the box-apparatus and secure food from the box on the side on which the positive form stimulus appeared The positive form (the triangle) was alternated from right to left according to certain carefully selected orders of presentation in which *the most probable chance score was 50% correct* (see 6) In case of error the subject was not allowed to turn and open the correct box, but was required to return to the starting-chair for another trial[4] For the most part, each subject was given 20 trials a day, although on a few occasions as many as 50 trials were given.

Before proceeding to describe the results secured in this experi-

[4]This procedure is different from that used by Lashley, Gulliksen, and others These investigators count as *a single trial* all of the successive trips made by the subject from the starting-point to secure food until one trip is finally successful (8, pp 40-41) The plan used in the present investigation is similar to that followed in this type of experimental work by Munn and others Any attempt at comparison of results in terms of trials required to learn is made practically impossible because of this difference in procedure followed by various investigators. It is the writer's opinion that the Lashley plan may be superior because, under it, the problem of position habits is automatically met as soon as it occurs.

ment, the opportunity of the subjects to secure cues will be considered. If differential cues did exist, subjects might have been able to meet the criterion of correct response without responding to the forms at all. The sensory aspects of the two boxes were identical throughout the experiment, each box contained food and there were no differential sound factors from trial to trial. The possibility of differential cues in connection with shifting the forms from side to side was thoroughly considered before trials with the subjects were undertaken. The following procedure was adopted to minimize the possibility of such cues. With the exception of the first trial, the experimenter went up to the form-presentation frame before each of the trials. He moved both the forms to the center of the presentation frame and out of view of the subject. Then he replaced the forms behind the windows. Whether or not the forms were changed from side to side, this manipulation was always made in the same way. To test for cues from this source, several different investigators who were engaged in other work with animals sat in the starting-chair and attempted to determine the order of presentation from the change of forms procedure. The experimenter went through the regular routine of form presentation with the windows covered so that the observer could not see the actual forms from trial to trial. Under these conditions, none of the investigators were able to make more than 50% correct responses. This indicates the improbability of differential cues arising from this source.

Another feature of the procedure that needed to be controlled was the starting-signal utilized. The subjects were given a slight touch in the middle of the back as a signal for them to leave the starting-chair and attempt to secure food. It was possible that differential cues could be given to the subjects by the experimenter in this fashion. The fact that this was not the case was demonstrated in several ways. In the first place, after the subjects had learned to respond to certain form combinations, another experimenter was invited to run the subjects through one day's trials. At the beginning of this series of trials, the new experimenter himself did not know which forms were positive and which were negative. The subjects were taken from the room following each single trial and the forms were changed during their absence. Then the new experimenter and the subject entered the room and the subject responded with the usual experimenter absent from the situation. Under these conditions the subjects continued to make perfect re-

sponses This indicated that their response was not dependent upon the experimenter or any possible cues that might have been given by means of the touch signal for starting. In the second place, after the subjects became thoroughly acquainted with the experimental routine, they started on each trial without waiting for a touch signal. This habituation of subjects to an experimental situation is a well-known phenomenon to investigators working with primates of various levels. The third fact which indicated that the touch signal was not utilized by the subjects in making differential responses under the experimental conditions of this study was the complete breakdown of discrimination when the subjects were presented with two identical forms. This phase of the study will be presented in connection with results.

There was a further important source of evidence that indicated that the subjects received no cues from the experimenter or the apparatus This fact was the breakdown of subjects during actual tests. When the subjects were presented with identical forms the experimenter might have expected a breakdown and thus influenced their behavior. Whether or not the subjects would break down during actual tests, however, was unknown to the experimenter.

Results

1. *Learning the Original Discrimination.* The subjects first were given 30 preliminary trials each in order to teach them to go from the starting-chair to the boxes and secure food. (During these preliminary trials plain white cardboards appeared in the form-presentation-frame windows. Both boxes were unlocked and contained food.) All the subjects learned this procedure without additional training Nancy, Moos, and Song had served formerly as subjects in studies of double alternation and had to learn to return to the starting-chair after securing each piece of food. Jimmy spent considerable time playing before he opened either box in his first two trials. Thereafter, however, he promptly opened a box immediately upon being given the starting-signal.

Following this preliminary training, the subjects were taught to open the box on the side on which a triangle was presented A white triangle (area 36 square inches) on a black background (10" x 10") was shown on one side of the apparatus and on the other side of the apparatus, a black area (10" x 10"). (See Figure 2) The number of trials required by each subject to learn the original discrimination,

TABLE 1
LEARNING THE ORIGINAL DISCRIMINATION
Positive stimulus white triangle on a black background
Negative stimulus total black (see Figure 2)

Trials	Percentage correct in 50 trials Nancy	Jimmy	Moos	Song	Remarks
50	L*	48	58	46	L at trial 20
100		56	66	54	
150		54	58	52	Song took a L position habit
200		78	62	60	
250		L	60	54	L at trial 220
300			66	46	
350			64	58	
400			52	62	
450			60	54	
500			56	60	
550			86	76	Special training, see text
600			94	90	Special training; see text
650			72	74	
700			78	82	
750			84	80	
800			88	86	
850			L	90	L at trial 830
900				L	L at trial 860
Total trials	20	220	830	860	

*L indicates point at which the criterion of learning (95% in 20 trials) was met

together with the percentage of responses correct throughout the learning series, are presented in Table 1 The criterion of learning was 95% correct in 20 trials.

Nancy learned the correct response at once, that is, her first 20 responses all were correct In connection with this immediate adaptation to the problem, the verbal behavior of this subject is of interest. On her first trial Nancy paused briefly and viewed the form-presentation-frame windows one of which now contained the triangle (1, Figure 2) Then she traced the general outline of the two upper sides of the triangle with her right forefinger and said, "That's a A" This performance was followed almost immediately by her opening the nearby (correct) box and taking food. For several trials she continued tracing the outline of the figure with her finger (either with her finger in the air or against the glass). Then gradually she stopped to view the stimuli from greater distances. By the tenth trial she did not leave the starting-chair until she had looked

back and forth from one stimulus window to the other. Several times such expressions as "Over der" occurred as she left the starting-chair and went directly to the correct box. Jimmy took 220 trials to meet the criterion of learning. After running about 160 trials, during most of which he had a position habit to the left, he showed signs of reacting to the triangle. His solution of the problem appeared comparatively suddenly. It was accompanied by a formulation which included the verbal response, "Dis one," and the tracing of the triangle as described above with Nancy.

The apes gave no evidence of progress in learning throughout their first 500 trials respectively. Song adopted a left position habit (see 10, p. 216), and Moos responded chiefly in simple alternation. At this point the forms were taken out of the form-presentation frame and placed in positions adjacent to the box lids. Under these conditions, the apes learned to respond correctly in about 50 trials apiece. Then by gradual changes the cards were moved from the box lids to positions immediately in front of the glass windows. This took about 50 more trials in the case of each ape, and was accompanied by only occasional errors. When the cardboard forms were replaced in the presentation frame more errors were made but the responses were never less than 70% correct. After about 250 additional trials apiece the apes finally learned the discrimination.

These facts indicate that the apparatus used in the present experiment would have been more satisfactory if it had provided for a more direct relationship between the form stimuli and the box lids. In designing the apparatus this possibility was considered. It would have been possible so to arrange the apparatus that the forms moved with the box lids as the latter were opened. In the work of Munn and Stiening (13) this was done by attaching the forms directly to the box lids. A more direct relationship between the box lids and the forms would have influenced the rate of learning the original discrimination. Whether or not the results secured in the later controls were influenced by the partial indirectness of the apparatus is unknown.

2. *Introduction of a Square as the Negative Figure.* After the subjects had learned to respond to the triangle, a small white square on a black background was introduced as a negative figure. In no case did this cause any upset. Squares of gradually increasing size were introduced until the negative figure was a white square of the same area as the triangle (36 square inches). The increase in size

of the square was continued until finally the negative figure was made totally white. This series of negative forms is shown in Figure 2 and the results secured appear in Table 2. Nancy and Jimmy looked at the squares a good deal when they first appeared but continued to make correct responses. In the case of each of these subjects the time came, as the squares increased in size, when several errors appeared. The children were trained at these points until they had made 10 successive correct responses each. Thereafter increases in the size of the negative figure caused no upsets. The apes went through this series of trials without error. It is possible in the light of the results secured in tests of the efficacy of the negative figure when used alone (see pp. 22-23) that it would have been better to have presented the square as a negative figure throughout the original training series.

At this stage the subjects were considered to have mastered the discrimination between a triangle on its base as the positive stimulus and a square as the negative stimulus. A series of tests and controls were then given to determine if these subjects could respond to form *per se*. The following sections present the nature of these tests and discussions of their results.

3. *Simultaneous Rotation of Triangle and Change of Negative Figure.* This test is considered by Munn and Stiening to be a critical test of the discrimination of triangularity *per se* (13, p. 86-87). In it the triangle (positive figure) was turned upside down. In this way the positive figure was the *same* form but a *new* "shape," according to Bingham. Also the negative figure was changed from a square to a circle. Success due to avoidance of the negative figure was precluded by this change. According to Hunter this kind of "problem would be puzzling to a human adult, unless he had been *told* to attend to triangularity!" (9, p. 331.) Miss Washburn's belief is that a subject in order to solve such a problem must have a capacity for abstract ideas (14, p. 320). Let us see what results were secured with the children and apes.

All subjects continued to react positively to the triangle under these changed conditions. An interesting type of behavior accompanied these correct responses. In every case the subjects hesitated on their trials under these new conditions, and, after looking from form to form, *they turned their heads about 60 degrees to one side or the other and viewed the triangle.* Then they made the correct responses. It will be noted that under these conditions, the subjects were en-

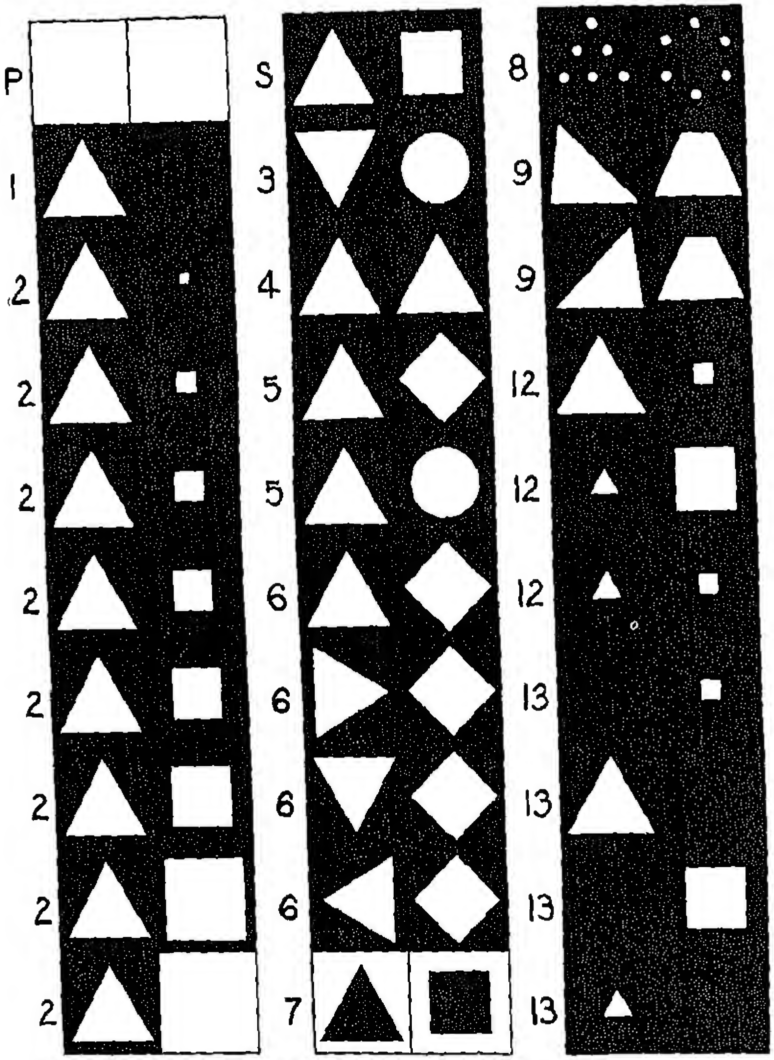

FIGURE 2

COMBINATIONS OF STIMULI

The positive form is on the left in each pair of stimuli. The numbers indicate tests in which each pair of stimuli were used. P—combination used during preliminary trials. S—standard combination. The forms are reduced to one-twentieth of their original size.

TABLE 2

RESULTS OF TESTS 2 TO 9

	Test condition (see Figure 2)	Trials and percentage correct: Nancy		Jimmy		Moos		Song	
1	Last 20 trials learning	20	100	20	95	20	95	20	100
2	Introduction of square as negative figure								
	1" square	10	100	10	100	10	100	10	100
	2" square	10	100	10	100	10	100	10	100
	3" square	10	100	10	100	10	100	10	100
	4" square	10	100	25	68	10	100	10	100
	5" square	10	100	10	100	10	100	10	100
	6" square	25	92	10	100	10	100	10	100
	8" square	10	100	10	100	10	100	10	100
	10" square	10	100	10	100	10	100	10	100
3	Rotation of triangle and change of negative figure	10	100	10	100	10	100	10	100
4	Triangle *vs* triangle	10	50	10	40	10	50	10	40
5	Changes of negative figure	20	100	20	100	10	100	10	100
6	Rotation of figures	20	100	20	100	20	100	20	100
7	Reversal of brightness	10	100	10	100	10	90	10	80
8	"Equivalent" figures	10	100	20	80	20	50	20	55
9	Changes in triangles	10	100	10	100	10	100	10	100
	Total trials to this point	205		415		1000		1030	

abled to view the triangle *as though it were on its base* Whether an inverted equilateral triangle has been rotated 180 degrees or 60 degrees has not been discussed in most studies of form discrimination. Actually the form card was rotated 180 degrees but for the subjects in the present study the *triangle* had been rotated in effect only 60 degrees. The verbal behavior which occurred during these tests is also of interest. Nancy hesitated on her first trial of this series and said, "Where's a A? I want cookie." She looked from figure to figure and approached the apparatus slowly. Then as she turned her head to the side and viewed the triangle she said, suddenly, "There's a A!" Immediately she made the correct response. In the writer's opinion this subject was administering her *own instructions* to herself.

The data secured in this test indicate that these responses were dependent in part upon a simple discrimination of a given "shape," i.e., a certain retinal distribution of light. Correct responses were made only after obvious head rotation took place Bingham's point that a triangle on its base and the same form inverted are different in "shape" holds, of course, only if the two forms are viewed with the eyes in one definite position. In the present experiment the subjects responded to the triangle *by making definite adjustments to its position in space* Presumably they thereby secured a retinal distribution of light similar to that to which they had been positively conditioned.

4. *Triangle versus Triangle.* It was possible that the subjects were responding in these trials not to the form of the triangle, but rather to the particular piece of cardboard out of which the triangle had been cut To test this, the subjects were given 10 trials each in which the positive figure was the same cardboard triangle to which they had learned to respond, and the negative figure was a newly-cut triangle of the same size (see Figure 2). In these trials a complete breakdown in the accuracy of response occurred in the case of all subjects. This indicates that the former correct responses of the subjects were not made possible by any specific stimuli they might have been receiving from the particular cardboard triangle used Also it indicates that differential responses were not made possible by other cues such as those which might arise from the touch signal for starting or from the way in which the experimenter changed the position of the forms from trial to trial. Evidently the methods used in the present study were such that consistently correct responses by subjects were dependent upon discrimination of form alone

5. *Changes of the Negative Figure.* The results secured in the tests described in Section 3 above indicate that accuracy of response was not dependent upon the particular negative figure used. To demonstrate further that the subjects could respond to the triangle as a positive stimulus the following stimulus combinations were used. The triangle on its base was the positive figure and a diamond and a circle (Figure 2) were used in random order as negative figures. Under these conditions the children and apes were given 20 and 10 trials respectively and all of their responses were correct.

6. *Rotation of Figures.* A series of trials was devoted to a study of the influence of rotation of both the positive and negative figures upon accuracy in the triangle-versus-square discrimination. The triangle was rotated to four different positions (Figure 2). As negative figure either a square or a diamond was used in random order. Throughout these trials no upsets of response occurred. An inspection of the rotated triangles in Figure 2 reveals the fact that the second, third, and fourth triangles have been rotated clockwise from the first triangle 90°, 180°, and 270° respectively, if one thinks in terms of actual manipulation of the form cards. If, however, one thinks in terms of how far it is necessary to turn one's head from side to side to see each of the triangles *as if* it were on its base, the second, third, and fourth forms have been rotated 30° to the left, 60° either way, and 30° to the right respectively. Also it will be noted that a diamond is in effect a square rotated 45°.

During this test it was noted that the subjects often rotated their heads to the side in viewing either figure but especially in viewing the triangle. This head-turning behavior suggests very strongly that the subjects had learned a response to a very specific stimulus, a triangle on its base, and that they behaved so as to recapture that stimulus. In some cases it was quite comical to witness the positions taken by both the children and apes in viewing the rotated figures. They even went so far as to "stand on their heads" on one or two occasions. This head-turning behavior was practically absent in tests other than those in which rotation of figures took place.

7. *Reversal of Brightness.* Throughout the training series, the subjects had learned to respond to white figures on black backgrounds. The stimuli used in this test were a black triangle and a black square on white backgrounds (see Figure 2). This change caused no interruption in the continued correct responses of the children. The apes made a few errors.

8. *"Equivalent" Figures* The next test was to see if the subjects could respond to "equivalent" figures (Figure 2). In this test, the triangle was represented by six small circles (white dots) placed where each corner and the mid-point of each side line of an equilateral triangle (inscribed inside a circle with a radius of 4") would be The negative figure was composed of six circles placed at points equidistant on the circumference of a circle (radius 4") The children were both able to make this transfer with little or no error In the case of the apes, however, the response to this new situation dropped at once to around 50% correct Nancy hesitated for several seconds before responding on her first trial of this test. As she started to grasp the correct box lid she said, "That's a funny A, isn't he" She made no errors on any trials of this test Jimmy, after several seconds of hesitation, on his first trial pointed to the circular arrangement of black dots and said, "I want dis." He missed trials 1, 2, 6, and 10 of the 20 trials he was given in this test. Moos got just half of his 20 trials correct. He made a big fuss after about 10 trials and attempted to tear the form frame apart. He took a long period of time to finish the series of trials. Song simply went back to a left position habit after his first trial and made 11 out of 20 responses correct.

9. *Changes in Triangles* This test was conducted to determine if the subjects could discriminate other triangles than the equilateral triangle previously used. The two forms of triangle used as positive figure are shown in Figure 2. They both have a base 9" long and an altitude of 8" As negative figure a trapezoid was used with bases 9" and 3" long and an altitude of 6" Thus the positive and negative figures had equal base lines and equal areas. All the subjects were able to discriminate these scalene triangles from the trapezoid without error. This indicates that their responses were not dependent upon the relatively long base line which the triangle has in comparison with many other figures of equal area, e g, the square It is possible that in this test the subjects were responding to the upper "point" of the triangle

10. *Triangle-and-Trapezoid Series* As suggested above, an important aspect of the response to triangularity may be the base line of the triangle It has been suggested that subjects may be enabled to respond to a triangle on the basis of the base line alone or on the basis of the apex of the triangle alone A series of trials were undertaken to determine, if possible, the dependence of response in

the present experiment upon these features of the triangle. Throughout these trials, an equilateral triangle 36 square inches in area was used as positive figure and different trapezoids were used as negative figures. In each case, the trapezoid had a base line equal in length to the base of the triangle and an area equal to the area of the triangle. The tops of the trapezoids varied in length from 3" to 1/8". Since this series of figures all had the same area, the altitude of the trapezoids increased with a decrease in the length of the top line. In other words, the general appearance of the trapezoid approached closer and closer to that of the equilateral triangle (see Figure 3).

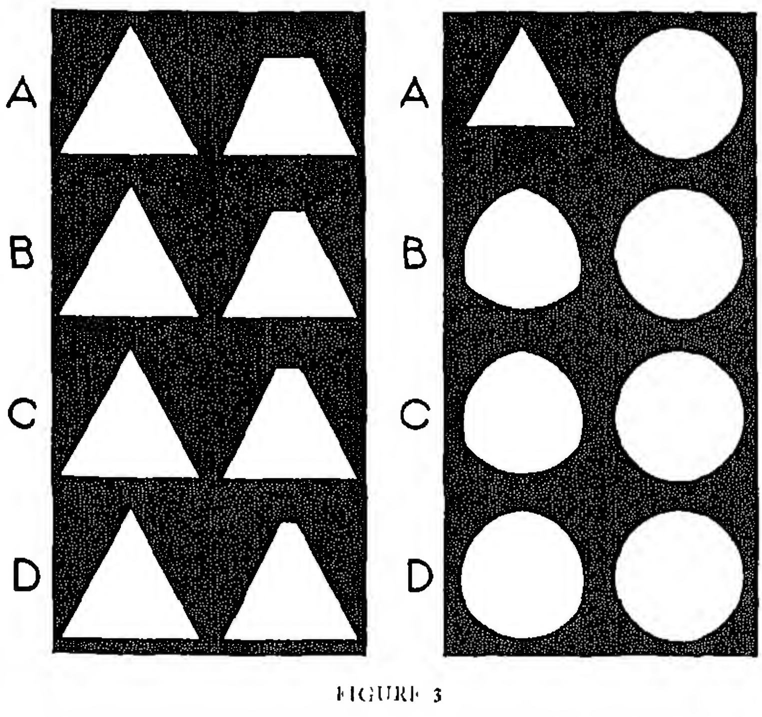

FIGURE 3

COMBINATIONS OF STIMULI USED IN TESTS 10 AND 11

The positive form is on the left in each pair of stimuli. Only the first four stages (*A* to *D*) of each test are shown. The forms are reduced to one-twelfth of their original size.

Table 3 shows that the children discriminated the triangle from the trapezoid up to the point at which the upper base of the trapezoid was only 1/4" long. When, however, this was reduced to 1/8", the children both dropped to 50% correct responses. Their verbal behavior under these conditions indicated that the figures were no longer differentiated by them. Nancy said, "The're two A's," and upon making several successive errors, "I can't have any cookie." Jimmy said simply, "The're two of 'em." The apes under these experimental conditions did not discriminate the triangle from the trapezoid with much success when the top base of the trapezoid was shorter than 2". Whether this difference in the behavior of the two groups of subjects was due to a difference in visual acuity or to a difference in the formulation of the problem by the subjects is not known.

This test demonstrated that the discrimination of triangularity is not necessarily dependent upon the relatively long base line typical of triangles. The discrimination in this series of tests was dependent upon slight differences in the upper "points" of two like-appearing forms. One is reminded of Bingham's statement ". . . apparent reactions to forms are the result of a keen perception of relative size differences" (3, p. 67).

11. *Triangle-to-Circle Series.* In order to test the dependence of the discrimination of triangularity upon a "point" or the three "points" of the triangle the following series of tests was undertaken. The negative figure was at all times a circle (radius 4"). The positive figure varied from a triangle (inscribable in a 4" circle) through a series of six "circular" triangles to a 4" circle. In the successive stages of this series, the sides of the triangle were rounded out more and more until finally they approached very closely to a true circle (Figure 3). In the first four of these "circular" triangles (*b*, *c*, *d*, and *e*) the three points were still present, though blunt, because the sides of these "circular" triangles were true arcs of larger circles. In the last two figures of the series (*f* and *g-h*) the points were rounded off. These figures were really circles "flattened" on three sides rather than "circular" or "bulged" triangles.

Let us turn now to the behavior of the subjects in this test series as shown in Table 3. The chimpanzees encountered considerable difficulty with these tests. In their trials on the combination of stimuli shown in Figure 3*c* they did no better than would be expected through chance. An inspection of Figure 3 shows that Test *d* in

Results of Tests 10 to 14

	Test condition	Nancy		Jimmy		Moos		Song	
		Trials and percentage correct							
	Total trials to this point	205		415		1000		1030	
10	Trapezoid-to-triangle series (base lines and areas equal)								
	a top of trapezoid 3″	3	100	3	100	3	100	3	100
	b top of trapezoid 2″	3	100	3	100	3	100	5	80
	c top of trapezoid 1½″	3	100	3	100	10	80	17	65
	d top of trapezoid 1″	3	100	3	100	14	64	20	45
	e top of trapezoid ¾″	3	100	3	100	20	55		
	f top of trapezoid ½″	5	100	5	100				
	g top of trapezoid ¼″	15	80	10	100				
	h top of trapezoid ⅛″	15	57	20	50				
11	Triangle-to-circle series								
	a 4″ circle *vs* triangle	3	100	3	100	3	100	3	100
	b 4″ circle *vs* triangle "bulged" ½″*	3	100	3	100	10	80	10	70
	c 4″ circle *vs* triangle "bulged" 1¼″	4	100	3	100	15	60	16	63
	d 4″ circle *vs* triangle "bulged" 1⅝″	5	100	3	100	17	47	16	50
	e 4″ circle *vs* triangle "bulged" 1¾″	5	100	6	100				
	f 4″ circle *vs* circle flattened ¼″	5	100	5	100				
	g 4″ circle *vs* circle flattened ⅛″	5	100	5	100				
	h 3⅞″ circle *vs* circle flattened ⅛″	10	100	5	100				
	i 4″ circle *vs* 4″ circle	8	25	7	43				
12	Relative size								
	a large triangle *vs* small square	5	100	5	100	5	100	5	100
	b small triangle *vs* large square	5	100	5	100	5	100	5	100
	c small triangle *vs* small square	5	100	5	100	5	100	5	100
13	Positive and negative stimuli presented alone								
	a total black *vs* small square	5	100	5	100	5	100	5	100
	b large triangle *vs* total black	5	100	5	100	5	100	5	100
	c total black *vs* large square	5	100	5	100	5	100	5	100
	d small triangle *vs* total black	5	100	5	100	5	100	5	100
14	Large triangle *vs* small triangle	to small		to small		to large		to large	
	Total trials	348		553		1140		1165	

*In interpreting these figures it must be remembered that the midpoint of the side of a triangle inscribed in a 4″ circle is 2″ inside the circumference of the circle Thus such a triangle "bulged" 2″ would be a true circle

this series requires a discrimination of two forms that are quite similar. If the sides of the "circular" triangle of this stage were "bulged" only ⅜" more the figure would be a circle The children encountered no difficulty with the tests of this series Even in Test *g* in which the circle was flattened only ⅛" on each of three sides the responses of these subjects were 100% correct If these were due to a "perception of relative size differences," the perception was a "keen" one indeed! Throughout this series of tests a slight size difference had existed in that the positive (triangular) figure had always been smaller than the circle. To control for this difference a 3⅞" circle was used in Test *h*. This circle was slightly smaller than the sixth stage of the "circular" triangle series (a 4" circle flattened ⅛") The children continued to respond 100% correct to this combination of stimuli. When, however, they were tested with two circles of equal size the accuracy of their responses broke down at once.

Were the children in this remarkable series of trials discriminating form (triangularity) *per se* or were they responding negatively to the circle? Doing the latter would require a high degree of form-discrimination ability in tests like *g* and *h*. The writer is inclined to believe that the children were responding to form. In the final tests of this series "shape" and size differences were very small. The most obvious difference between the figures in Tests *g* and *h* is that one form is slightly "lop-sided" on three sides *This factor, three-sidedness, is triangularity per se.* A critical test in this case might have been to flatten the negative figure (the circle) on *four* sides Would the responses in such a test have continued toward the three-sided form? Such a test was not made and the question remains unanswered

12. *Relative Size* The nature of the tests of the influence of relative size upon the discrimination of form are shown in Figure 2 and Table 3. In some of these trials, a large triangle was presented together with a small square In other trials a large square was presented together with a small triangle Throughout this series, all of the subjects continued to respond correctly to the triangle, whether it was large or small Evidently, the response to triangularity is relatively independent of the size factor.

13 *Positive and Negative Stimuli Presented Alone.* This test was made to answer a question suggested by Weidensall (15) She suggested that an experiment on visual discrimination should seek to determine the efficacy of the positive and negative stimuli. Test

5 above showed that the subjects used in the present experiment could respond correctly to the positive stimulus (triangle) throughout changes in the negative stimulus. This finding is similar to that of Munn and Stiening who say, ". . . . the child responded *positively* to one form at one time, being unaffected by a change in the negative one, and responded *negatively* to the negative stimulus when the positive form was changed. This type of response has never been observed in any other animal as far as the writers are aware" (13, pp 87-88) In the present study tests were made to determine the efficacy of the positive and negative stimuli, not only throughout changes of the *other* stimulus, but also when used *alone*.

It was decided to use two sizes of triangle as positive forms and two sizes of square as negative forms. Twenty trials were given during each of which *one* of these forms appeared versus total black (see Figure 2) The four combinations each appeared five times in random order throughout the 20 trials. They were as follows

Positive stimulus		Negative stimulus
Total black	*vs*	Small square
Large triangle	*vs.*	Total black
Total black	*vs*	Large square
Small triangle	*vs*	Total black

All the subjects responded throughout this series of trials without error They responded *positively to the triangle* each time it appeared, and *negatively to the square* when it was exposed This behavior is consistent with the training these subjects had received It demonstrates conclusively that both positive and negative stimuli were effective *as such* when presented *alone* Both chimpanzees and children can respond to a *part* of the combination of stimuli, *either positively or negatively* They are not dependent upon the *whole configuration*

14 *Large Triangle vs. Small Triangle* In the last 10 trials of the experiment the subjects were each presented with a large triangle (36 square inches) versus a small triangle (4 square inches) It is of interest to note that under these conditions both children responded to the smaller of the two triangles as positive figure and both apes responded to the larger of the two triangles as positive figure Nancy verbalized her "preference" in the words, "I like the cute one." The reason for this difference in the behavior of the two groups of subjects is not known Possibly it is related to a difference in behavior observed in the second experiment of this series (5, pp. 36-39)

There, also, the apes reacted to the *larger figures* (backgrounds) rather than to the *smaller figures* (forms) whenever the backgrounds presented differential cues.

Summary and Conclusions

In this study two chimpanzees and two two-year-old children were trained and tested in form discrimination with identical experimental procedures. The work was done in an alternation box-apparatus equipped with a new type of form-presentation frame. The subjects were not dependent in their responses upon cues from the experimenter or from the apparatus and method. No differential sensory cues were present other than those inherent in the combinations of form stimuli themselves. All the subjects learned to react positively to a triangle. The children demonstrated mastery in 20 and 220 trials respectively, and the chimpanzees required 830 and 860 trials respectively The discrimination of the triangle was not affected by rotation of either positive or negative figures, by changes in the kind of triangle presented, by the relative size of the positive and negative figures, or by various changes of the negative figure When "equivalent" figures made of dots arranged to form the outline of a triangle and a circle were presented instead of solid figures like those used throughout most of the experiment, the children continued to discriminate the triangular figure with little or no error. The accuracy of the chimpanzees' discrimination, however, dropped to the level of chance. In a test in which the negative figure (a trapezoid) was made to approach closely the positive figure (a triangle), the performance of the children far excelled that of the chimpanzees In this test the discrimination depended chiefly upon differences in the upper "points" of the figures The base lines of the figures were equal The same relative results were secured when the positive figure (a "bulged" triangle) was made closely to approach the "shape" of the negative figure (a circle) In this test the children succeeded in discriminating between very closely related figures Their performance was far superior to that of the chimpanzees The children also showed slight superiority to the chimpanzees in reacting to figures in which reversal of brightness had been introduced. Both groups of subjects were able to react "toward" the positive figure (either a large or small triangle) and "away from" the negative figure (either a large or small square) when either of these figures was presented alone versus total black.

When presented with two triangles of equal area and brightness the performance of all subjects fell to the level of chance. The verbal behavior of the children indicated that they had formulated the problem verbally and that their behavior was partly controlled by verbal processes

Thus the children were successful in satisfying the five of the criteria for discrimination of triangularity upon which they were tested. They were tested on the sixth criterion in the experiments reported in the second paper of this series (5). These results demonstrate unequivocally that the children could respond to form (triangularity) *per se*. According to Hunter this task "would be puzzling to an adult unless he had been told to attend to triangularity!" (9, p. 331). The children used in the present investigation, however, were told nothing about what they were to do in connection with the discrimination of form. Their verbal behavior in the problem-solving situations involved in the present experiment shows that they *told themselves what to do*. In the absence of instructions administered by the experimenter these subjects utilized self-administered instructions. (See Hunter, 11, p 335.)

The chimpanzees were successful in discriminating the triangle when it was inverted and opposed to a new negative figure (a circle) Certain aspects of the behavior of the chimpanzees in these tests indicated that they might have been reacting to "shape" rather than to form *per se*. In each trial in which the triangle was rotated the chimpanzees (and also the children) turned their heads to the side in such a way that they could view the triangle as though it were on its base. The failure of the chimpanzees to discriminate "equivalent" figures and their relatively unsuccessful discrimination of triangles from trapezoids and of "bulged" triangles from circles throws additional doubt upon the discrimination of form *per se* by these subjects. The results of the present study do not definitely establish the discrimination of form *per se* by chimpanzees

From the results of this experiment the following conclusions concerning the problems investigated may be stated

1 Two-year-old children can discriminate form (triangularity) *per se* Chimpanzees can discriminate triangles, but the data obtained in the present experiment do not prove conclusively that their responses were to form *per se*

2 In the discrimination of form by these subjects both the positive stimuli and negative stimuli are effective as such when presented alone versus total black.

3 The children definitely exhibit symbolic behavior in connection with the discrimination of form They associate gestural and verbal behavior with the triangle, they formulate the general nature of the problem verbally, and, in the absence of instructions, they formulate verbally their own instructions.

These conclusions concern chiefly the first of the two problems raised in 1913-1914 by Hunter (9), Bingham (1, 2), and Washburn (14) Additional evidence upon that problem, the discrimination of form *per se,* is presented in the second paper of this series (5) which attacked the other problem, namely, the influence of *background* upon the discrimination of *form*

References

1 Bingham, H C Size and form perception in *Gallus domesticus* *J Anim Behav*, 1913, 3, 65-113.

2 ——— A definition of form *J. Anim. Behav*, 1914, 4, 136-141

3 ——— Visual perception of the chick. *Behav Monog.*, 1922, 4, No. 4 Pp 104

4 Fields, P E. The development of the "concept" of triangularity in the white rat *Psychol. Bull*, 1931, 28, 683-684

5 Gellermann, L. W Form discrimination in chimpanzees and two-year-old children. II. Form versus background *J Genet Psychol.*, 1933, 42, 28-50

6. ——— Chance orders of alternating stimuli in visual discrimination experiments. *J Genet Psychol.*, 1933, 42, 206-208.

7 ——— The double alternation problem V The behavior of chimpanzees in a double alternation box-apparatus (*In preparation*)

8 Gulliksen, H Studies of transfer of response. I Relative versus absolute factors in the discrimination of size by the white rat *J Genet. Psychol*, 1932, 40, 37-51

9 Hunter, W. S The question of form perception. *J Anim. Behav.*, 1913, 3, 329-333.

10 ——— The auditory sensitivity of the white rat *J Anim Behav*, 1914, 4, 215-222

11. ——— Human behavior. Chicago: Univ Chicago Press, 1928 Pp 355.

12. Munn, N L The relative efficacy of form and background in the chick's discrimination of visual patterns. *J Comp Psychol*, 1931, 12, 41-75

13. Munn, N L., & Stiening, B. R. The relative efficacy of form and background in a child's discrimination of visual patterns *J Genet Psychol*, 1931, 39, 73-90.

14 Washburn, M F. Recent literature on the behavior of vertebrates *Psychol. Bull*, 1913, 10, 318-328.

15 Weidensall, J A critique of the discrimination test: a study in animal behavior *Psychol. Bull.*, 1912, 9, 57-59

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LA DISCRIMINATION DE LA FORME CHEZ LES CHIMPANZES ET LES ENFANTS ÂGÉS DE DEUX ANS: I. LA FORME (TRIANGULARITÉ) *PER SE*

(Résumé)

On a entraîné et testé deux chimpanzés et deux enfants âgés de deux ans pour la discrimination de la forme avec des processus expérimentaux identiques On a fait ce travail au moyen d'un appareil composé d'une boîte à alternation fournie d'un nouveau type de cadre pour présenter les formes On a obtenu des données pour les problèmes suivants (1) la discrimination de la triangularité *per se*, (2) l'efficience relative des stimuli négatifs et des stimuli positifs dans la discrimination des formes visuelles, et (3) le comportement verbal des enfants à l'égard des divers aspects de cette situation à problème On a fait des tests de l'influence sur la discrimination de la triangularité (*a*) des changements de la figure négative; (*b*) de la rotation des figures positives et négatives, (*c*) du renversement de la clarté, (*d*) de la grandeur relative, (*e*) des figures solides et des figures "équivalentes"; (*f*) du sommet et de la ligne de la base; et (*g*) de l'arrondissement graduel des côtés d'un triangle vers la forme d'un cercle Les résultats ont montré que les enfants ont pu répondre à la forme (triangularité) *per se* Ils ont associé les symboles verbaux et ceux de gestes au triangle, ils ont formulé verbalement la nature générale du problème, et en l'absence de renseignements ils ont formulé verbalement leurs propres renseignements Les chimpanzés ont pu répondre aux triangles mais les données actuelles ne prouvent pas que leurs réponses ont été à la forme *per se*

GELLERMANN

DIE FORMENUNTERSCHEIDUNG BEI SCHIMPANSEN UND BEI ZWEIJAHRIGEN KINDERN I DIE DREIECKIGKEIT AN SICH

(Referat)

Es wurden zwei Schimpansen und zwei zweijahrige Kinder mit genau denselben experimentellen Verfahren in der Formenunterscheidung dressiert und geprüft Man arbeitete mit einem Anwechslungskastenapparat (alternation box apparatus) welches mit einer neuen Art von Ramen zur Präsentierung der Form ausgestattet worden war Es wurden in Bezug auf folgende Aufgaben Befunde gesammelt (1) die Unterscheidung der Dreieckigkeit an sich, (2) die relative Wirksamkeit der negativen bezügl der positiven Reize bei der Unterscheidung visueller Gestalten; und (3) die Sprachtätigkeit der Kinder im Zusammenhang mit den verschiedenen Seiten der gegenwärtigen Aufgabesituation Man machte Prüfungen der Einwirkung auf die Unterscheidung der Dreieckigkeit mit (*a*) Änderungen der negativen Gestalt; (*b*) Rotation sowohl der positiven wie der negativen Gestalten, (*c*) Umkehrung der Helligkeiten; (*d*) relativer Grosse, (*e*) Kubik- bezügl "aequivalenten" Gestalten, (*f*) Gipfel bezügl Grundlinie, und (*g*) allmählicher Abrundung der Seiten des Dreiecks in der Richtung eines Kreises Die Befunde haben erwiesen, dass die Kinder im Stande waren, auf Form (Dreieckigkeit) *an sich* zu reagieren Sie assoziierten Gebärde- und Sprachsymbole mit dem Dreieck, sie formulierten sprachlich die allgemeine Beschaffenheit der Aufgabe, und beim Fehlen der Anweisungen formulierten sie sprachlich ihre eigenen Anweisungen Die Schimpanzen waren im Stande, auf Dreiecke zu reagieren, die gegenwärtigen Befunde beweisen aber nicht, dass ihre Reaktionen der Form als solche galten

GELLERMANN

FORM DISCRIMINATION IN CHIMPANZEES AND TWO-YEAR-OLD CHILDREN. II. FORM VERSUS BACKGROUND*[1]

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LOUIS W GELLERMANN

INTRODUCTION

In the experiment described in the previous paper (1) chimpanzees and two-year-old children were trained and tested in the discrimination of form (triangularity) *per se* Both groups of subjects were able to respond to a triangle under a variety of test conditions. With the children definite evidence was secured of response to form *per se*. The present experiment continued the investigation of form discrimination in these two groups of subjects The problem attacked in the present experiment was the question raised by Hunter (4) of the influence upon the discrimination of form of the background upon which a figure appears.

Hunter pointed out that the subject in the typical form-discrimination experiment viewed not *two forms alone* but rather *two forms each in more or less of a definitely shaped background*. Hunter's position has been well summarized by Munn, as follows·

> "It was suggested that the form discrimination apparatus be so constructed as to allow an independent control of the separate aspects of *form* and *background* This, Hunter claimed, could be achieved by inserting variously shaped tunnels into the alleys of the Yerkes-Watson discrimination apparatus The background would depend upon the shape of the tunnel, viz, the triangular-shaped tunnel would cause the form to appear on a triangular background; if the tunnel were changed to a square shape, the *identical* form would now appear on a square background. With such an arrangement it should be possible to determine whether the animal was responding to a configura-

*Accepted for publication by Carl Murchison of the Editorial Board.

[1]The experiments reported in this series were done at the suggestion and under the supervision of Professor Robert M Yerkes while the writer was a National Research Fellow in the Laboratories of Comparative Psychobiology at Yale University

tion which included *form* and *background* or to the *form* or *background* alone Because this control of form and background had never been carried out Hunter claimed that the evidence for form discrimination in animals was equivocal" (5, p 41-42).

The problem of form versus background has been studied by Munn with chicks (5), and by Munn and Stiening with a child 15 months old (6) In the latter investigation "it was found that the shape of the background on which the form appeared was not an effective part of the stimulating conditions" (p. 87)

The present study sought to investigate the following problems, all related to the general problem of form discrimination:

1. What is the relative efficacy of form versus background in the discrimination of visual patterns in these subjects?
2. What is the relative efficacy of the negative versus the positive stimuli in the discriminaton of visual patterns of these subjects?
3. What is the influence of having learned certain pattern combinations upon learning of various new combinations of figures and background?
4. What are the verbal responses of the children in connection with the various aspects of the present problem situations? Do these verbal responses seem in any essential way associated with the discrimination of form in its various aspects?

The plan of attack in the present experiment was similar to that of Munn and Stiening (6). In most trials of this experiment a cross was the positive stimulus. Tests were made to determine whether the subjects could respond to this cross as positive figure regardless of the form of backgrounds in which the figures appeared, regardless of the particular negative figure which was opposed to the cross, and regardless of rotation of both figures and backgrounds Additional tests were conducted to determine whether the subjects had learned to respond positively to the cross, negatively to other figures, or both The nature of these tests and the way in which they were applied will be described in connection with the presentation of results.

Apparatus and Method

The same alternation box-apparatus and form-presentation frame described in the previous paper (1, pp 5-7) were used in the present study. The subject's task was to go from a starting-chair to the box-apparatus and open one of two boxes, thereby securing food

Food always could be secured on the side on which the positive pattern appeared.

Each pattern used throughout the present experiment consisted in a black figure in a white background on a black field. The backgrounds upon which the forms appeared were always of equal area and brightness At different times the backgrounds themselves had the form of triangles, squares, circles, diamonds, stars, and crosses. They were always white and had an area of 26 34 square inches (the area of an equilateral triangle inscribed in a 4½" circle) The figures were always black and were 2 square inches in area Forms used as figures included crosses, squares, diamonds, circles, stars, triangles, and half-moons Both figures and backgrounds were so arranged that their geometrical mid-points exactly coincided This insured that the figure always appeared in the "middle" of the background, that the figure and background appeared in the "middle" of the presentation-frame windows, and that this position of figure and background was not disturbed by rotation of the cardboards in which either figure or background were cut.

Three pieces of cardboard made up each of the form combinations. The back card was black and was uncut. The middle card was white and had a small hole (the form) cut in it. The front card was black and had a large hole (the background) cut in it. When these three cards were placed together part of the back card appeared through the aperture in the middle card as the "form." This "form," together with a portion of the middle cardboard, appeared through the aperture in the front cardboard giving in effect a black "form" upon a white "background" in a black field Actually, of course, the superposition of background continues almost indefinitely. The majority of shifts in the position of the positive stimulus required a change of figure only In these cases the changes were effected by moving the middle cards. In some of the tests in which both figure and ground were changed, both from side to side and in kind, it was necessary to move both the front and middle cards The back cards (black) were left unchanged from trial to trial.

The subjects were the same two-year-old children and young chimpanzees used in the previous experiment (1). The children were Jimmy, the son of a member of the Yale Medical School Staff, and Nancy, the writer's daughter. The chimpanzees were members of the primate colony of the Laboratories of Comparative Psychobiology at Yale. Moos, male, Number 11, estimated age 5 years; and Song, male, Number 7, estimated age 6 years

Throughout the experiment, identical procedures were used with all subjects Trials were conducted every day at 11.00 o'clock It was felt that in this way the subjects would be reasonably hungry throughout their trials. Food was used as reward for all subjects *At no time were any of the subjects given verbal instructions of any kind.* Directions connected with keeping the subjects on the starting-chair during the intervals between trials were unnecessary during this study The possible effect of simple verbal instructions on both children and chimpanzees has been commonly overlooked in most previous investigations The daily routine for each subject was identical with that described in the previous paper (1) The subjects were thoroughly habituated to the routine They gave excellent cooperation at all times Each subject was given from 20 to 50 trials per day, depending largely upon the nature of the tests involved.

All aspects of the experiment were carefully controlled. The sensory aspects of the two boxes were identical throughout the experiment; each box contained food, and there were no differential sound factors from trial to trial. The order of alternating the pattern stimuli was such that *the most probable chance score was 50% correct* (2). It was unnecessary to use a starting-signal in this experiment. The fact that a complete breakdown of discrimination resulted when the subjects were presented with two identical patterns indicates definitely that the subjects did not utilize incidental "cues" in making their differential responses under the experimental conditions of this study

Results

1. *Learning the Original Discrimination* The combination of stimuli which the subjects were taught to discriminate in this experiment is shown in Figure 1. This is the same pair of patterns used by Munn and Stiening (6) in their study of the relative efficacy of form and background in the discrimination of visual patterns The number of trials required to learn this original discrimination by each of the subjects, together with the percentage of responses correct throughout the learning series, are presented in Table 1 The criterion of learning was 100% correct in 10 trials.

Nancy and Jimmy both performed their first 10 trials under these conditions without error They showed definite evidence of avoidance of the square (the negative figure) during these trials Several

TABLE 1

LEARNING THE ORIGINAL DISCRIMINATION

Positive stimulus, black cross in a white diamond background
Negative stimulus black square in a white diamond background
(see Figure 1)

Trials	Percentage correct in 10 trials Nancy	Jimmy	Moos	Song	Remarks
10	100L*	100L	30	50	Avoidance of square
20			50	40	
30			50	60	
40			40	50	Moos almost refused to work
50			60	40	
60			50	50	
70			50	30	
80			40	60	Song fell into a L position habit
90			50	50	
100			60	50	
110			60	60	
120			80	40	
130			100L	50	
140				60	
150				60	
160				50	
170				70	
180				70	
190				80	
200				100L	
Total trials	10	10	130	200	

*L indicates point at which the criterion of learning (100% in 10 trials) was met

times these subjects approached the incorrect box Before they attempted to open the incorrect box, however, they looked at the negative figure (the square) and immediately went to the other box and opened it. This behavior is consistent with the results described in the previous paper (1).

In that study the square was used as negative figure more than any other form and all the subjects learned to respond negatively to the square. On her ninth and tenth trials Nancy traced the general outline of the cross with her right forefinger just before opening the correct box During the learning trials neither of the children made verbal responses which seemed to be related to the figures

Moos and Song learned the discrimination in 130 and 200 trials

respectively. After 30 trials, in which most of his responses had resulted in failure to secure food, Moos almost refused to continue work on the problem. Song responded indifferently back and forth from right to left for about 70 trials. Then he began to go to the left-hand box on every trial. This left position habit had been characteristic of Song's responses whenever he failed to distinguish between positive and negative stimuli in the previous study (1). In that study when the subjects were presented with a large versus a small triangle the children responded to the small figure as positive and the apes responded to the large figure as positive. Evidently this is what took place in the learning of the present discrimination. The children responded to the smaller forms (which were *different*) and learned the discrimination at once. The chimpanzees, however, evidently did not respond to the smaller forms (the figures). The larger figures (the backgrounds) were *identical* in form and it was not possible for the chimpanzees to make differential responses on the basis of them. That the chimpanzees tended to respond to the larger forms (the backgrounds) rather than to the smaller forms (the figures) is definitely indicated by the results secured in Tests 4 and 5 below.

Moos after 108 trials and Song after 173 trials gave evidence of responding to the figures rather than to the backgrounds. On these trials the chimpanzees first showed a form of behavior that was characteristic for all subjects during many of the trials throughout the balance of the study. Bringing their faces very close to the presentation-frame windows, *they traced the outline of the figures* in a rather crude fashion. This "tracing" was usually made by the children with their right forefingers. The chimpanzees made the tracing movements chiefly with the back side of their crooked fingers. Part of the time they definitely used their forefingers also, although this was not typical. Sometimes the tracing was done on the glass windows of the presentation frame, at other times it was done in the air. This "tracing" behavior of the chimpanzees appeared entirely spontaneously. It occurred without possibility of human suggestion and imitation of human action. This type of response has never been observed before in infra-human primates. In the opinion of the writer the "tracing" behavior had definite symbolic significance and was of fundamental importance. Soon after this behavior appeared in the chimpanzees they both succeeded in mastering the discrimination between the cross and the square. Possibly they were aided in this mastery by avoidance of the negative figure (the square).

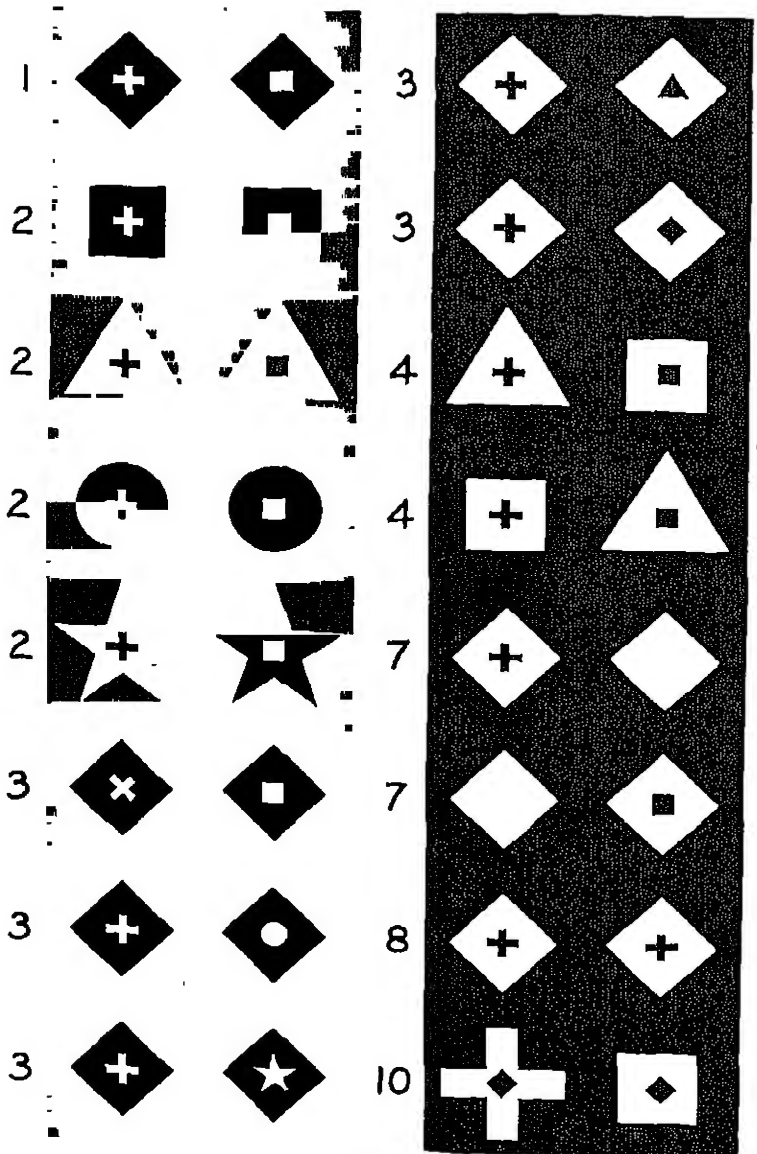

FIGURE 1

COMBINATIONS OF STIMULI

The positive form is on the left in each pair of stimuli. The forms are reduced to one-twelfth their original size.

2 *Changes of Backgrounds.* These tests were made to determine whether the subjects could discriminate between a cross and a square when these figures appeared in backgrounds other than the diamonds used during the learning period. This question of the rôle of the background in the discrimination of visual patterns was originally raised by Hunter (4). The results of the present test demonstrate that the subjects could react to the cross as positive figure regardless of the backgrounds upon which the figures appeared These results are shown in Table 2 Squares, triangles, circles, and stars were used as backgrounds None of these changes affected the correctness of response of the children. The apes were somewhat disturbed when triangles were used as backgrounds They were able to perform 10 successive trials correctly, however, after a small amount of training. Thus all the subjects could respond to figure without reference to the particular background in which it happened to appear.

TABLE 2
RESULTS OF TESTS 1 TO 10

Test conditions (see Figure 1)	Trials and percentage correct							
	Nancy		Jimmy		Moos		Song	
1. Trials to learn	10		10		130		200	
2 Changes of backgrounds								
a both squares	10	100	10	100	10	100	10	100
b both triangles	10	100	10	100	20	80	30	67
c both circles	10	100	10	100	10	100	10	100
d both stars	10	100	10	100	10	100	10	100
3 Changes of figures								
a rotate cross 45°	10	100	10	100	10	100	10	100
b negative figure a circle	10	100	10	100	10	100	10	100
c negative figure a star	10	100	10	100	10	100	10	100
d negative figure a triangle	10	100	10	90	16	63	30	00
e negative figure a diamond	10	100	10	100	10	100	10	100
4. Differing backgrounds	10	100	10	90	43	40	40	00
5 Both backgrounds and negative figures changing (see Table 3)	20	100	20	95	20	75	20	70
6 Retraining	10	100	10	100	10	100	12	83
7 Positive and negative stimuli presented alone	10	100	10	100	10	100	10	50
8 Cross *vs* cross	10	40	10	40	10	50	10	40
9 Retraining	10	100	10	100	10	100	10	100
10 Cross shifted to background	25	100	25	84	20	45	20	50
Total trials	195		195		359		452	

3 *Changes of Figures.* During this test diamond-shaped backgrounds were used. In the first part of the test the cross was rotated 45° as shown in Figure 1. Would this change in pattern affect the accuracy of discrimination? All of the subjects made 100% correct responses under these changed conditions In each case *the subjects turned their heads in viewing the rotated cross.* On her ninth trial Nancy said, "That's a X picture" Thereafter from time to time she continued to call the cross "X" *even after it was returned to its original position.* This verbal behavior supplemented the "tracing" with her forefinger described above.

The negative figure was changed in successive groups of trials from a square to a circle, a star, a triangle, and a diamond. Results secured are shown in Table 2 Except when the triangle was used as the negative figure, none of the subjects made any errors in these tests This demonstrates that, although the subjects might have been responding *negatively* to the square in the learning trials, they now could respond *positively* to the cross It is interesting to note, however, that this newly formed association (cross as positive figure) was not as strong as the older discrimination habit which the subjects had learned in the previous study (triangle as positive figure). Jimmy responded positively to the triangle the first time it appeared. Moos responded positively to the triangle during six successive trials and thereafter to the cross Song, however, made 30 successive errors going to the triangle as positive stimulus every time. Without doubt he could have been trained to make the discrimination of cross versus triangle, but he was not given additional trials on this combination

4 *Differing Backgrounds* The behavior just described indicated a tendency on the part of most of the subjects to respond to a triangle when one appeared. It was decided to make the following critical test of this tendency. A triangle and a square were here used as backgrounds In the previous study the subjects had been taught to discriminate between these forms. As figures the cross-versus-square combination was used The order of presentation for the backgrounds was simple alternation (LRLRLRLRLR for the triangle) The order of presentation for the cross followed one of the random presentation orders used regularly (see 2, No 19—RLLRRLLRRL) If the children responded to the smaller form (the figure) as might be expected from Test 14 of the previous study they would make no errors in this test. The apes, however, might be expected to respond to the larger forms (the backgrounds)

TABLE 3

COMBINATIONS OF STIMULI USED IN TEST 5
(All features changed from trial to trial except the cross)

Trial	Left side Figure in background		*vs*	Right side Figure in background	
1	Star	Star		Cross	Diamond
2	Cross	Star		Square	Circle
3	Triangle	Diamond		Cross	Circle
4	Star	Square		Cross	Star
5	Cross	Triangle		Diamond	Star
6	Triangle	Triangle		Cross	Square
7	Diamond	Star		Cross	Triangle
8	Cross	Triangle		Square	Circle
9	Cross	Square		Circle	Circle
10	Cross	Diamond		Star	Triangle
11	Triangle	Square		Cross	Diamond
12	Square	Star		Cross	Square
13	Cross	Triangle		Circle	Diamond
14	Cross	Circle		Diamond	Triangle
15	Circle	Square		Cross	Triangle
16	Cross	Circle		Star	Diamond
17	Triangle	Circle		Cross	Square
18	Square	Diamond		Cross	Star
19	Cross	Diamond		Circle	Square
20	Cross	Circle		Diamond	Star

That is just what happened. Nancy made no errors and Jimmy missed only his first trial. Moos made 23 successive errors, then got 3 out of 10 trials correct, and finally ran 10 successive trials without error. He learned to make the correct discrimination in 33 trials. Song, however, made 40 successive errors, i.e., all of his responses were to the larger form (the triangle). On the basis of his training in the previous study, of course, he made 40 correct responses. These results confirm those secured in Test 14 of the previous study. They definitely indicate the tendency of the children to respond to the smaller of two forms and the tendency of the chimpanzees to respond to the larger of two forms

This difference in the behavior in the two groups of subjects is further demonstrated in the next test.

5. *Both Backgrounds and Negative Figures Changing* In this test 20 trials were given in which a combination of the controls used

in the last three tests was undertaken. Backgrounds were changed every trial (Test 2). Different negative figures were used from trial to trial (Test 3), and the backgrounds differed from one another on every trial (Test 4). Combinations of stimuli used in this series of 20 trials are shown in Table 3. Five different forms were used as background, each one appearing with every other one twice, once on the right and once on the left. As negative figure five different forms were used four times each The particular order in which the backgrounds and the negative figures appeared was determined by lot The cross as positive figure was placed on the right or left side according to random presentation orders No. 12 and No 8 (2). Throughout this series of trials all aspects of the stimuli were changed from trial to trial except the one figure, the cross itself.

Nancy went through this series of trials without error and practically without hesitation. Jimmy missed only trial 6 in which he responded to the triangle in a triangle rather than to the cross in a square (Figure 2). Both Moos and Song missed trials 6, 9, 10, 14, and 17. Song missed trial 12 also. The analysis of the performance of the apes in these trials reveals the fact that every time a triangle was used as background the apes went to the side on which it appeared. In trials 5, 7, 8, 13, and 15 it happened that the cross appeared within the triangle as figure. Therefore the apes made correct responses on each of these trials. In trials 6, 10, and 14, however, going to the side of the triangular background caused these subjects to make erroneous responses The fact that the children

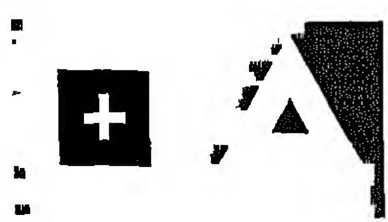

FIGURE 2

COMBINATION OF STIMULI USED IN TRIAL 6 OF TEST 5

The positive form is on the left. In actual use in this trial it was on the right (see Table 3). The forms are reduced to one-tenth of their original size.

responded consistently to the smaller figures while the apes responded partly to the smaller figures but where possible to the larger figures (the triangular backgrounds) comprises a definite difference in the behavior of these two groups of subjects. Throughout this series of trials the apes seemed to hesitate most when neither a square nor a triangle appeared as either background. This was particularly noticeable in trials 16, 18, and 20, in all of which these subjects responded correctly to the cross. The consistent tendency of the chimpanzees to respond to the larger figure whenever possible may indicate a difference between their visual acuity and that of the children or it may indicate a difference in the point of *near vision* On the basis of the general behavior of chimpanzees as they view small objects, one is led to believe that apes must be very close to small objects in order to react well to them. This is not so true for children. It is possible that such a difference is also the explanation of the superiority of the children to the chimpanzees in the "trapezoid-and-triangle" series and in the "circular triangle" series reported in the previous paper (1). In those tests the children were able to discriminate very fine size and "shape" differences, compared with the chimpanzees.

6. *Retraining.* Following the above test all subjects were given a brief period of retraining on the original combination of stimuli shown in Figure 1. Nancy, Jimmy, and Moos made 100% correct responses in their first 10 trials each Song missed 2 trials and then performed 10 successive trials correctly

7 *Positive and Negative Stimuli Presented Alone.* Diamonds were used as backgrounds in this test. Ten trials were given each subject. In five of these the cross appeared as positive figure in one background and no figure appeared in the other background In the other five trials the square appeared as negative figure in one background and no positive figure was used Nancy, Jimmy, and Moos performed this series of trials without error. Song, however, always went *to the background in which no figure appeared!* Thus he performed correctly only those trials in which no positive stimulus appeared and missed the trials in which the positive stimulus (the cross) did appear. The results for three of the subjects indicate that in learning to discriminate between two figures on like backgrounds the positive figure and the negative figure both had become effective These results supplement those found in Test 13 of the previous paper (1). Both tests definitely indicate that *children and chim-*

panzees can respond to a part of the whole configuration of stimuli either positively or negatively.

8. *Cross versus Cross.* To test whether the responses were actually to the form of the cross and not to any specific cues the subjects might have received from the particular piece of cardboard in which the cross was cut, the subjects were now tested with two crosses. The cross which had been used in the earlier trials was considered the positive stimulus and a newly-cut cross, the negative stimulus. In the case of all subjects there was a complete breakdown under these conditions as shown in Table 2.

9. *Retraining.* In preparation for Test 10 the subjects each were given 10 trials of further training on the discrimination of a cross versus a square on diamond backgrounds. All subjects made 100% correct responses in these trials.

10. *Cross Shifted to Background.* In all of the tests thus far described emphasis was placed upon the discrimination of the central forms used in the combinations of stimuli The positive stimulus has consisted in a small cross in a variety of backgrounds, the latter appearing upon 10" by 10" black fields. What would the subjects do if the central figures were made identical and the differential cue were made to appear in the background? The discrimination of the cross from the square when used as the center figure has been demonstrated. In the absence of a differential cue in the *figures* of the form combinations, would the subjects react positively to the form of a cross appearing in the *background?*

In this test diamonds were used as figures with a cross and a square used as backgrounds. The cross was considered the positive stimulus Results secured are shown in Table 2. The only subject to respond correctly to this shift in cue was Nancy After considerable hesitation and such verbal responses as "Where is X" and "The're two of 'em," she opened the box on the side of the cross background Thereafter she responded correctly without hesitation. Jimmy missed 4 of his first 5 trials. Several times he said, "The're two of 'em" On his sixth trial he paused several seconds before the positive stimulus combination and traced the outline of the cross background over and over again. All the rest of his trials in this test were correct. The chimpanzees in 20 trials each responded as if by chance. This behavior was surprising in view of the tendency of the chimpanzees to respond always to a *triangular background* as positive stimulus whenever one appeared. Also they had shown some

evidence of responding negatively to a square background (such as appeared in the present test) in Test 5 In the present test the chimpanzees did not demonstrate discrimination of form (the cross). The writer is inclined to believe that this fact indicates insufficient training on the cross as positive figure rather than inability to discriminate form *per se*

11 *Learning New Combinations of Stimuli* In this test the problem was: What is the influence of having learned certain pattern combinations upon learning various new combinations of figures and background? The reasons for undertaking this experiment involved several related problems as follows (1) Nancy and Jimmy learned the original discrimination of cross versus square in this study immediately They showed definite evidence of *avoidance of the negative figure* (the square) during those trials By avoidance of the square they made "correct" responses, and this fact aided them in learning to respond positively to a new figure (the cross) This same phenomenon was noted by Munn and Stiening (6, pp. 86-87). Was this facilitation typical and would it appear in a series of tests on various new combinations of figure and background? (2) With all subjects the response to the cross as positive figure was somewhat disturbed by the appearance of triangles as negative figure. The subjects had been trained to the triangle as positive figure in the previous study In such situations Nancy showed marked hesitation behavior and Jimmy made errors by responding to the triangle (The behavior of the apes in Tests 4 and 5 further demonstrated this interference, but actually these results had not been secured when the present test was undertaken) Was such *interference* typical and would it appear in this test? (3) The head-turning behavior of the subjects in making responses to rotated figures suggested the following question Is the discrimination of two identical forms, differing only in degree of rotation more difficult or less difficult than the discrimination of two *different* forms? (4) The children responded verbally to the problem situations most definitely when faced with changes in the combinations of stimuli During the introduction of new problem situations in the present test, it was hoped to secure additional data concerning the verbal formulation of form discrimination and also concerning the self-administration of instructions by the children With these problems in mind let us turn to a consideration of the learning tests Test 11 included 10 subtests in learning new combinations of stimuli In these, diamond

backgrounds were used The combinations of forms used as positive and negative figures are shown in Figure 3 The number of trials required to learn and the number of errors made by each subject in these new combinations are shown in Table 4.

Both children made the discrimination in Test *a* without error Both the star and circle had formerly been used as negative figures. Of the two, however, the star certainly resembled the cross more closely In Test *b* the square and the cross were presented in the

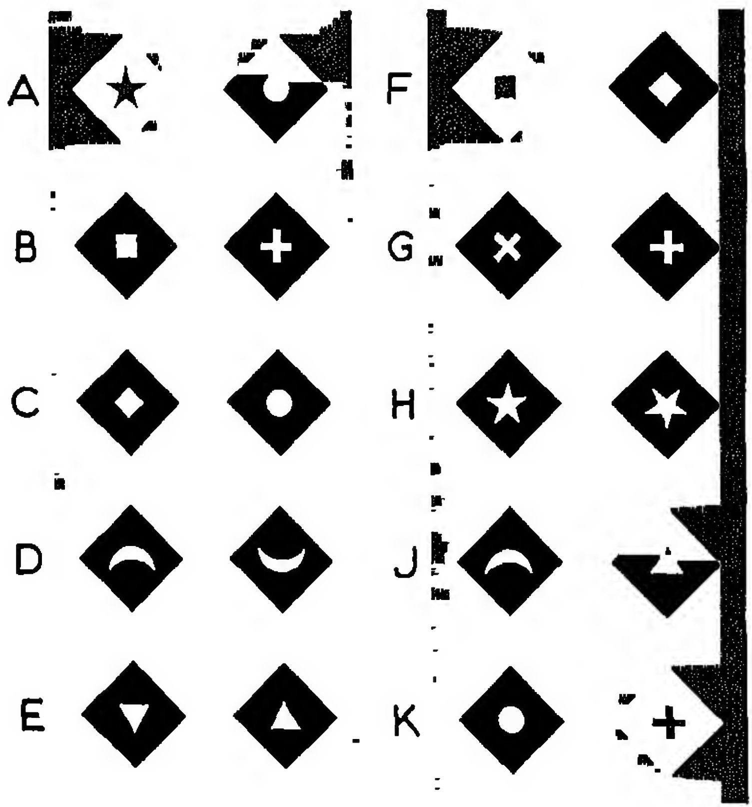

FIGURE 3

COMBINATIONS OF STIMULI USED IN TEST II

The positive form is on the left in each pair of stimuli The forms are reduced to one-twelfth of their original size

TABLE 4

RESULTS OF TEST 11 LEARNING NEW COMBINATIONS OF STIMULI

	Combination of stimuli (see Figure 3)		Trials required to learn*					
			Nancy		Jimmy		Moos	
	Positive	Negative	Trials	Errors	Trials	Errors	Trials	Errors
a	Star	Circle	0	0	0	0		
b	Square	Cross	5	5	19	19	50	45
c	Diamond	Circle	0	0	0	0		
d.	Half-moon (point down)	Half-moon (point up)	18	8	50	23	50	24
e	Triangle (point down)	Triangle (point up)	2	2				
f	Square	Diamond	1	1				
g	Cross (rotated 45°)	Cross (original)	1	1	6	5		
h.	Star (point up)	Star (point down)	30	15	50	29	50	28
j	Half-moon	Triangle	0	0				
k.	Circle	Cross	2	2				
	Total trials in Test 11		159		165		150	

*The criterion of learning was 100% correct for 10 successive trials The scores given in this table are numbers of trials occurring prior to the 10 trials during which the criterion of learning was met in each test. Jimmy did not learn in Tests *d* and *h*

reverse relationship to that in which they had appeared previously. Nancy and Jimmy made 5 and 19 successive errors respectively Thereafter they both reacted to the square as positive without error. On her first trial on this reversed combination of cross and square, Nancy said, "Over here," and pointed to the cross as she opened the box on its side. Following each of her five errors she complained as she returned to the starting-chair by saying, "I haven't got any cookie." On her sixth trial, after considerable hesitation, she pointed to the square, saying "Yes, yes, yes," and opened the box on that side. After securing the cookie she turned and pointed to the cross, saying, "*This is no, no, no, no, now.*" On trial 7 she said "This one right here," pointing to the square On trial 8 she said, "Right over here to this one," pointing again During the rest of the trials she said nothing Jimmy said nothing during his 19 successive errors on this test, but hesitated considerably on the last two of these trials. On trial 20 he said as he pointed to the square, "Over here, huh?," and then as he secured the cookie, "I found it" On his next two trials he said, "This way, this way, this way," as he approached the box on the side of the square. These examples of

verbal behavior are particularly significant because *they occurred before the actions implied took place.* Evidently the children were instructing themselves in responding to the form stimuli Test *c* was performed without error by both children. In it the circle was negative as had been the case in Test *a*. This possible facilitation might have accounted for the immediate solution of the test. Nancy, before making her first response to the diamond, pointed to the circle saying, "This one, no, no," and then pointing to the diamond, "This one, yes, yes"

In Tests *d* to *h* inclusive, identical forms were used as positive and negative figures These forms differed from one another in degree of rotation In Test *d* entirely new figures, half-moons, were used. Nancy required 18 trials and made 8 errors in learning this discrimination Jimmy did not succeed in learning the combination in 50 trials. Nancy learned the discrimination in Test *e* after making two errors and the discriminations in Tests *f* and *g* after one error in each In all of these tests the first correct trials were accompanied by verbal responses of the general type, "Yes, yes, yes," and by pointing to the particular positive form concerned.

In Test *h* two stars were presented as figures. The positive star was placed with one point directly up and the negative star was placed with one point directly down. Thus the negative figure was rotated in effect 36 degrees from the position of the positive figure Jimmy did not learn this discrimination in 50 trials. Nancy missed just half the 30 trials she was given in her first day's work on this test. Near the end of this series of trials she almost refused to work. Her talk about the problem was profuse, but she did not solve it During the last few trials she began to cry and to stamp her feet following erroneous responses. She finished this series of trials evidently as far from a solution of the problem as she had been before starting the test The manner in which she formulated and solved this "star" problem was observed quite accidently by the writer. Following her supper on the day in which the 30 trials described above took place, Nancy crawled into my lap while I was reading the evening newspaper This behavior was habitual for Nancy. After a few minutes my reading was suddenly interrupted by Nancy's exclamation, "Oh, look, Daddy, look, look, look" This statement was accompanied by pointing to an advertisement in the paper I looked at the general place indicated by her pointing, but failed to observe anything unusual Then Nancy remarked, "Look,

Daddy, that one's up side down" What she was describing by this statement will become apparent to the reader by inspection of Figure 4 At the top of the advertisement was a row of eight stars, *one of which was actually up side down in relation to the other seven.* It was the type of printer's error which adults commonly overlook. For this particular child on this particular occasion it proved a most noteworthy occurrence I drew the incident to a close by putting the newspaper away without comment Next day in the experimental situation Nancy walked up to the forms and looked from star to star Then she said, "That one's up side down," quickly turned to the other side, and made the correct response to the positive (point-up) star. Thereafter her responses in this test were 100% correct This incident gives a clear-cut picture of the verbal solution of a problem of form discrimination. Evidently, the seven stars in one position as opposed to one star "up side down" made possible a differentiation which the child had not been able to make in the

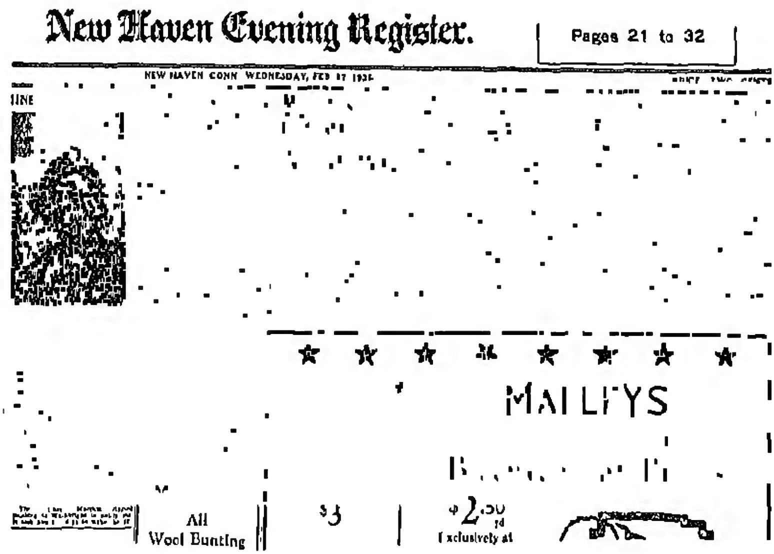

FIGURE 4

Photograph of a Portion of a Newspaper

It will be noted that one of the stars is up side down in relation to the other stars. How this fact aided one of the subjects in formulating a problem solution is described in the text

experimental situation in which only one star appeared in each position.

In general, the subjects encountered more difficulty in Tests *d* to *h* inclusive in which the figures differed only in degree of rotation than they encountered in other tests in which the two figures were different in form. This fact was further confirmed by results in Tests *j* and *k* in which the discriminations between figures of different form were easily and quickly learned.

In Test 11 Moos was given 50 trials in Tests *b, d,* and *h* He showed no progress toward learning in any of these tests, and made only 53 correct responses in his 150 trials.

The results of Test 11 may be briefly summarized as follows · In Tests *a, c,* and *j* the previous learning of certain pattern combinations *facilitated* the learning of new combinations of figures and background. *Interference* of previously learned pattern combinations in learning a new combination of figure and background was encountered in Test *b* Tests *d* to *h* inclusive demonstrated that the discrimination of two identical forms differing only in degree of rotation is more difficult than the discrimination of two *different* forms (Tests *a, b, c, j,* and *k*). Additional data of considerable importance were secured concerning the verbal behavior of the children in the discrimination of form. The results secured in Test 7 demonstrated conclusively that both positive and negative stimuli were effective as such when presented alone. In the present test it was observed that the children associated with the different positive stimuli the verbal response, "Yes, yes, yes, yes" Also they associated the verbal response, "No, no, no, no," with the different negative stimuli. These verbal responses served as instructions administered by the children *to themselves* on how to react to the particular stimuli concerned *Every verbal solution that was evident was made preceding the manual solution of the problem.* In this, the present results bear out completely the findings in experimental work concerning the time relationship of verbal and manual solution of the double alternation problem (3).

Summary and Conclusions

In this study two chimpanzees and two two-year-old children were trained and tested in form discrimination with identical experimental procedures The work was done in an alternation box-apparatus equipped with a new type of form-presentation frame. All aspects

of the experiment were rigidly controlled at all times The subjects were not dependent in their responses upon cues from the experimenter or from the apparatus and method. No differential sensory cues were present other than those inherent in the combinations of form stimuli themselves. All the subjects learned to discriminate between a cross and square as figures in diamond backgrounds. The children learned this discrimination without error due possibly to avoidance of the square as negative figure. The chimpanzees encountered considerable difficulty in learning the discrimination because of their tendency to respond to the form of the *backgrounds* All subjects were able to respond to the cross as positive figure regardless of the form of backgrounds in which the figures appeared, regardless of the particular negative figure utilized, and regardless of rotation, except that the *chimpanzees were greatly disturbed in their discrimination whenever a triangle appeared either as figure or as background.*[2] Both the children and the apes could respond positively to the cross and negatively to other figures when these forms were *presented alone* The children were able to discriminate the cross when it appeared as a differential cue in the background. The apes did not make this discrimination

The children were superior to the chimpanzees in the discrimination of form *per se* and in adapting to changes in the combinations of stimuli. The verbal behavior of the children indicated that these subjects formulated their problems symbolically and utilized self-administered instructions in the different tests. *Every verbal solution that was evident clearly was made before the children made the correct responses* On the basis of these facts it is evident that a large part of the superiority of the children to the chimpanzees in making the discriminations involved in these tests was due to their ability to short cut to problem solution by means of verbal behavior (symbolic processes)

From the results of the present experiment the following conclusions concerning the problems investigated in this study may be stated:

1. Chimpanzees and two-year-old children can discriminate form (the cross) *per se* In this discrimination the children proved super-

[2] In this connection it should be noted that Moos and Song had received 1140 and 1165 trials respectively in the previous study in which the triangle *was* the *positive form,* as compared with a total of 509 and 452 trials respectively in the present experiment.

ior to the chimpanzees when tested under identical experimental procedures as utilized in the present study This was true in spite of the fact that the chimpanzees seemed to be throughout the investigation somewhat better motivated than the children

2 These subjects can discriminate form (a cross) *per se* regardless of the background in which it appears They were able to respond to the cross as positive figure regardless of the form of backgrounds in which the figures appeared, regardless of the particular negative figure utilized, and regardless of rotation Here also the children were superior to the apes

3 Both facilitation and interference in learning new pattern combinations may occur due to previously learned combinations of figures and background. In learning new pattern combinations the discrimination of two *identical* forms differing only in degree of rotation is apparently more difficult than the discrimination of two different forms.

4. In the discrimination of visual patterns by these subjects both the positive stimuli and negative stimuli are effective as such when presented alone. The children and chimpanzees responded successfully to parts of the whole configuration of stimuli either positively or negatively

5. Both chimpanzees and children gave evidence of symbolic behavior associated with the discrimination of form. All the subjects were observed "tracing" the outlines of form (the cross) with their fingers The children also exhibited several kinds of verbal behavior which were related significantly to various aspects of the discrimination of form

The relative abilities here demonstrated for chimpanzees and children are consistent with (unpublished) results secured for these subjects in the double alternation problem The superiority of the human subjects is closely associated with their utilization of verbal behavior.

References

1 GELLERMANN, L W Form discrimination in chimpanzees and two-year-old children. I Form (triangularity) *per se* *J Genet. Psychol.*, 1933, **42**, 3-27.

2 ——— Chance orders of alternating stimuli in visual discrimination experiments. *J. Genet Psychol.*, 1933, 42, 206-208

3 ——— The relationship of the verbal and manual solutions of alternation problems in a stylus temporal maze (*In preparation*).

4 HUNTER, W S The question of form perception *J Anim Behav.*, 1913, **3**, 329-333
5 MUNN, N L The relative efficacy of form and background in the chick's discrimination of visual patterns *J Comp Psychol*, 1931, **12**, 41-75
6 MUNN, N L, & STIENING, B. R The relative efficacy of form and background in a child's discrimination of visual patterns *J Genet Psychol*, 1931, **39**, 73-90

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LA DISCRIMINATION DE LA FORME CHEZ LES CHIMPANZÉS ET LES ENFANTS ÂGÉS DE DEUX ANS II. FORME ET FOND

(Résumé)

On a entraîné et testé deux chimpanzés et deux enfants âgés de deux ans pour la discrimination de la forme avec des processus expérimentaux indentiques On a fait ce travail au moyen d'un appareil composé d'une boîte à alternation fournie d'un nouveau type de cadre pour présenter les formes On a obtenu des données pour les problèmes suivants, (1) l'efficience relative de la forme et du fond dans la discrimination des formes visuelles, (2) l'efficience relative des stimuli négatifs et des stimuli positifs dans la discrimination des formes visuelles, (3) l'influence de l'apprentissage de certaines combinaisons de formes sur de diverses nouvelles combinaisons de figures et de fonds, et (4) le comportement verbal des enfants à l'égard des divers aspects de cette situation à problème. On a fait grand nombre de tests utilisant sept formes diverses comme figure et six formes diverses comme fond Pendant ces tests seulement la figure positive (une croix) est restée constante. Comme test final le "repère" a été changé de la figure au fond On a fait aussi des tests avec de nouvelles combinaisons et des renversements des premières combinaisons de formes, et aussi avec des formes identiques à un différent degré de rotation Les enfants ont éte supérieurs aux chimpanzés dans la discrimination de la forme et dans l'adaptation aux changements des combinaisons de stimuli Dans la discrimination des formes visuelles par ces sujets les stimuli positifs et les négatifs ont été efficaces comme tels quand on les a présentes seuls Tous les sujets ont répondu avec succès aux parties de toute la configuration de stimuli ou positivement ou negativement La facilitation et l'interférence dans l'apprentissage des nouvelles combinaisons de formes se sont trouvées à cause des combinaisons de figures et de fonds premièrement apprises Dans l'apprentissage des nouvelles combinaisons de formes la discrimination de deux formes identiques à un différent degré de rotation seulement a été plus difficile que la discrimination de deux formes différentes Les chimpanzés et les enfants tous deux ont montré un comportement symbolique associé à la discrimination de la forme On a remarqué que tous les sujets ont "tracé" les contours de la forme (la croix) avec les doigts Les enfants ont montré aussi plusieurs sortes de comportement verbal qui ont une relation signifiante avec les divers aspects de la discrimination de la forme

GELLERMANN

FORMENUNTERSCHEIDUNG BEI SCHIMPANSEN UND BEI ZWEIJAHRIGEN KINDERN· II. FORM UND HINTERGRUND

(Referat)

Es wurden zwei Schimpansen und zwei zweijährige Kinder mit genau den selben experimentellen Verfahren in der Formenunterscheidung dressiert und geprüft. Man arbeitete mit einem Abwechslungskastenapparat welches mit einer neuen Art von Ramen zur Prasentierung der Form ausgestattet worden war. Es wurden in Bezug auf folgende Aufgaben Befunde gesammelt. (1) die relative Wirksamkeit von Figur und Hintergrund bei der Unterscheidung visueller Gestalten; (2) die relative Wirksamkeit der negativen bezugl der positiven Reize bei der Unterscheidung visueller Gestalten, (3) was fur eine Einwirkung dadurch auf das erlernen verschiedener neuer Verbindungen von Figuren und Hintergründen ausgeubt wurde, dass man schon gewisse Gestaltkombinationen bemeistert hatte; und (4) die Sprachtatigkeit der Kinder im Zusammenhang mit den verschiedenen Seiten der gegewartigen Aufgabesituation Es wurde eine grosse Anzahl Prüfungen gemacht bei denen sieben verschiedene Formen als Figur und sechs verschiedene Formen als Hintergrund verwendet wurden Bei allen Prüfungen wurde nur die positive Figur (ein Kreuz) konstant erhalten. Als letzte Prufung wurde die "Weisung" ("cue") von der Figur auf den Hintergrund abgelenkt Es wurden auch Prufungen ausgeführt mit Neuverbindungen und Umkehrungen fruherer Formverbindungen und ebenfalls mit identischen Formen die sich in dem Grad der Rotation unterschieden. Die Kinder waren in Bezug auf die Formenunterscheidung und die Anpassung an Änderungen in den Reizverbindungen den Schimpansen überlegen Bei der Unterscheidung visueller Gestalten durch diese Versuchspersonen waren sowohl die positive wie die negative Reize als solche wirksam wenn sie allein dargeboten wurden. Alle Versuchspersonen reagierten richtig auf Teile der gesammten Reizgestalt, entweder positiv oder negativ. Sowohl Bahnung wie Hemmung bei dem Lernen neuer Gestaltverbindung fand, als Wirkung fruher erlernter Figuren- und Hintergrundverbindungen, staat. Bei dem Lernen neuer Gestaltverbindungen war die Unterscheidung zwei identischer Formen, die nur in Bezug auf den Grad der Rotierung verschieden waren, schwieriger, als die Unterscheidung zwei verschiedener Formen Sowohl Schimpansen wie Kinder erstatteten Beweis fur symbolische Tatigkeit im Zusammenhang mit Formenunterscheidung Es wurde bemerkt, dass alle Versuchspersonen die Umrisse der Form (Kreuz) mit den Fingern aufzeichneten Die Kinder erwiesen auch verschiedene Arten der Sprachtätigkeit die in einem wichtigen Zusammenhang standen mit verschiedenen Seiten der Formunterscheidung.

GELLERMANN

A STUDY OF ACTIVITY AND POSTURES IN INFANTS' SLEEP*[1]

From the Yale Clinic of Child Development

DOROTHY POSTLE MARQUIS

Sleep postures and the amount and distribution of activity during sleep have recently been investigated in children of preschool and school age and in adults (1, 6, 9, 10, 16) The present experiment represents a similar study of these aspects of sleep during the first year of life For both a psychological and physiological approach to sleep problems and for the study of developmental aspects of behavior, this period presents interesting possibilities. First, the characteristics of the sleep of infants may be compared with the characteristics of sleep of older children and adults Is the sleep of the adult a product of development, or has it reached developmental maturity at birth? Secondly, by the study of the postures and movements of infants during sleep, a favorable opportunity is presented for the investigation of certain developmental phases of behavior which must of necessity be more indirectly approached when the infant is awake and reacting to a much greater diversity of stimulating situations The condition of sleep constitutes, in fact, a form of experimental control not otherwise obtainable.

The present report is concerned with the investigation of the amount and distribution of activity in day and night sleep, and of the sleeping postures in day naps. Thirteen infants, all under the age of one year, served as subjects These infants were carefully selected to represent a "normal group," on the basis of (1) health, as determined by medical history, (2) normal behavior, as determined by the Gesell developmental scale administered at stated intervals during the year, and (3) an average socio-economic level of their respective families The observation of the day naps was made under the following conditions: Nine infants, beginning at the age

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[1]This study was made under the auspices of the National Research Council with the direction of Dr Arnold Gesell at the Yale Clinic of Child Development

of eight weeks or a little more, were brought to the Yale Clinic of Child Development at regular four-week intervals for 12- or 36-hour individual observation throughout the first year. One or two morning naps of each of these infants were observed therefore at monthly intervals during the year. A record of postures and activity during the nap was made in two ways. An automatic minute-by-minute record of all major movements was made by means of a specially devised apparatus attached to the bedsprings and in circuit with a polygraph Whenever the bedsprings moved, the circuit through the recording pen of the polygraph was completed. Calibration of the instrument indicated that any movement as large as the movement of head or limb of a 13-pound infant would be recorded. The records were tabulated by one-minute intervals, i.e , any minute in which activity occurred was counted as an active minute regardless of the fact that the number of interruptions might vary. This method discounts the differences in weight of the sleeping infants The polygraph contained, in addition to the activity pen, two other pens for registration of time in minutes and of signal marks made by the observer Additional record was furnished by a qualitative description by the observer (author) of all postures and body movements of the infant during the sleep period. The 3-inch polygraph paper, moving at the rate of 2 inches per minute, provided ample space for the written record simultaneous with the automatic record of activity

The naps, for the most part, took place on the front porch in a standard crib. This out-of-door sleep was arranged in order that the experimental conditions at the Clinic would as nearly as possible approximate home nap conditions The observer and polygraph were located on the inside of a large window opening onto the porch, in a position where all movements of the infant were readily observable Arms and head were uncovered except on cold days, when the infants wore cap, coat, and mittens. The use of very soft pliable covering made the contour of the child's trunk and legs easily observable, so that movements of flexion or extension could be described. An infant was regarded as "asleep" when his eyes had been closed for one minute, and "awake" when his eyes remained open for an equal time.

Activity in night sleep was recorded with Johnson kinetographs (10), modified to give a time line in 1-minute rather than 5-minute intervals. Calibration of these instruments indicated that their

sensitivity approximated that of the instrument employed for nap records The investigation of night sleep was made with eight infants. Four of these were infants whose day naps were studied in the manner described above A record of a week's night sleep at home was made at intervals of four weeks on each of the four infants, beginning at the age of 20 or 24 weeks and continuing to the age of 36 or 40 weeks Four additional infants were studied at the New Haven Civic Home.[2] Their ages, during the experimental

TABLE 1

SUMMARY OF THE AMOUNT AND DISTRIBUTION OF ACTIVITY IN DAY AND NIGHT SLEEP FOR ALL SUBJECTS

Group A: records of one or two days' naps at an interval of four weeks during the time specified; Group B records of one week's night sleep every four weeks during the time specified, Group C. records of consecutive nights during the time specified

	Day sleep				Night sleep			
Subject	Age in weeks	Av no active minutes per hour	Av length quiet periods	S D (σ) length quiet periods	Age in weeks	Av no active minutes per hour	Av length quiet periods	S D (σ) length quiet periods
	Group A							
J K	8-20	14 4	5 4	2.3				
B E.	8-32	11 5	8 1	4 9				
J.C	20-48	17 3	9 1	3 7				
J M	28-52	4.7	11 3	1 9				
S.H	36-52	6 7	9 2	2 6		*Group B*		
B D	8-48	12 1	6 4	1.6	24-36	23.8	5 5	.94
B W	8-52	11 6	6 0	1 4	24-40	21 8	4 8	55
C B	8-52	10 4	7 7	2 7	24-39	20 9	5 5	1 48
R F	16-28	16 1	7 0	3 7	20-32	23 5	4 8	74
						Group C		
B A.					3-10	27 6	3 8	76
J Mc					7-13	23 2	5 1	1.12
R G					9-11	27.3	4 6	1 20
H G					16-23	27 0	4 8	69
Mean		10 5	7.8			24.4	4 9	
S.D		3 5	1 7			2 4	0 5	

[2]The writer wishes to express appreciation for the cooperation of the staff at the New Haven Civic Home, especially to Dr Margaret Bronson, Mrs Florence B Turner, and Miss Mary E Pierce

period, ranged from 3 to 23 weeks (see Table 1). Continuous nightly records were taken with these infants throughout the period of observation.

Two measures of activity, comparable in both day and night sleep, have been employed: (*a*) average length of the quiet periods during sleep, and (*b*) average number of minutes per hour in which activity occurred These measures give a record of both the amount and the distribution of activity.

Results

Activity in Day Naps. Table 1 presents the massed data for each infant. The average length of the quiet periods in the day naps was 7.8 minutes, and the average number of "active minutes" per hour was 10.6 This means that, if an infant slept two hours, he might be expected to be stirring during 21 minutes of that time. These active minutes would be scattered so that the average time between them would be about 8 minutes

Figures 1 and 2, however, show that the amount of activity in the nap during the first year does not remain constant from month to month. The day naps become more quiet as the infant grows older The average number of active minutes per hour decreases and the average length of the quiet period increases with age. This was true of every infant

The length of the periods of activity varied little. Since 1 minute was arbitrarily employed as a minimum measure, all values were in excess of this amount. The average length of the active period ranged from 3.5 minutes at 16 weeks to 1.15 minutes at 48 weeks.

In order to determine which part of the nap was least restless, the percentage of quiet minutes in each consecutive 30-minute interval of the nap was computed. These percentages were as follows: first half-hour, 87.5%, second, 71%, third, 68%; and fourth, 46.5% The quietest sleep, therefore, occurs immediately after the infant falls asleep, and activity increases gradually from this time to waking. This was true of all infants at all ages.

Little relation was found between the length of the nap and the time required to "go to sleep," except in a few extreme cases. On the few occasions when an infant lay awake for more than 30 minutes after being placed in the crib, his nap was correspondingly

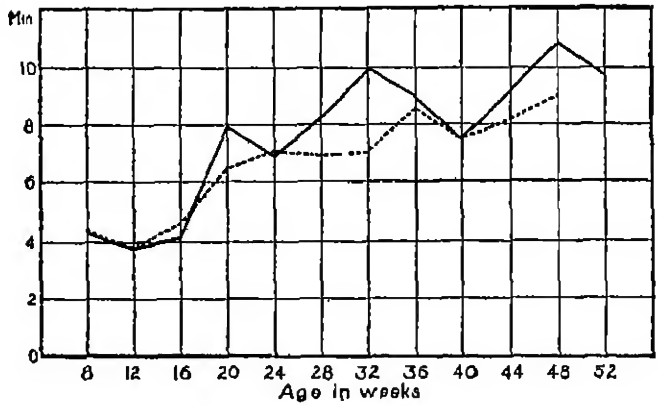

FIGURE 1

Average Length of the Quiet Periods in Day Naps According to Age

The solid line represents the mean of all subjects, the dotted line, the mean of three subjects on whom records were secured throughout the entire year.

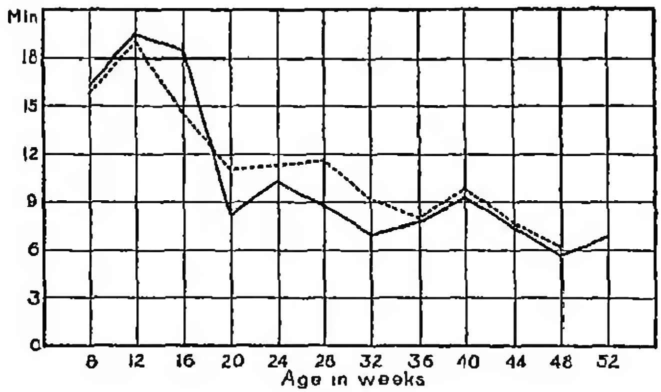

FIGURE 2

Average Number of Active Minutes per Hour in Day Naps According to Age

The solid line represents the mean of all subjects, the dotted line, the mean of three subjects on whom records were secured throughout the entire year

TABLE 2
COMPARISON OF THE ACTIVITY IN DAY AND NIGHT SLEEP OF FOUR INFANTS

	Night sleep		Day sleep	
Age in weeks	Av no. active minutes per hour	Av. length quiet periods	Av no active minutes per hour	Av. length quiet periods
24	21 4	5 71	11.2	6 85
28	21 8	5 39	10 3	8 39
32	21 9	4 92	9 1	7 14
36	25 4	4 47	7 9	8.52
Mean	22 6	4 91	9 8	8.65

shortened This accords with Sherman's findings on nursery-school children (17).

Activity in Night Sleep. Table 1 shows that the average number of active minutes per hour in night sleep was 25 4, and the average length of the quiet periods, 4.9 minutes. Table 2 gives a comparison of the activity of day and night sleep for the four infants whose day and night sleep was examined. This table shows (*a*) that the average length of the quiet period in day sleep is almost twice as much as in night sleep; (*b*) that the average number of minutes active during night sleep is more than twice as much as in day sleep; and (*c*) that during the period from 24 to 36 weeks,[8] day sleep becomes more quiet and night sleep more active. Since, according to Figures 1 and 2, the decrease in activity of day sleep is less during the period from 28 to 40 weeks than it is at the beginning and the end of the year, it is possible that the differences between night and day sleep might have been accentuated if observations of night sleep had been made at the latter ages.

It was impossible under present experimental conditions to study in detail the effect of day naps upon activity in night sleep. In the case of one infant (C.B.), however, the afternoon nap was omitted from the age of 34 weeks. Activity in the night sleep of this infant had been steadily increasing from 24 weeks, as measured both by the length of the quiet periods and the average number of active minutes per hour. The average length of the quiet periods had decreased from 7.0 minutes at 24 weeks to 5.6 minutes at 28 weeks

[8]Observations at 20 and 40 weeks are not included in the table since only one infant was studied at these ages.

and 4.7 minutes at 32 weeks. The average number of active minutes per hour had likewise increased from 19 1 at 24 weeks and 18.9 at 28 weeks, to 22 4 at 32 weeks. At 36 weeks, after the afternoon nap had been omitted for two weeks, the values changed to 5.93 minutes for the length of the quiet period and 17 2 for the number of active minutes per hour. Measurement of activity one month later, however, showed that the quieting effect had been only temporary, since *activity had at this time increased beyond any of its former levels to* an average of 26 8 active minutes per hour and to a value of 4.3 minutes for the average length of the quiet period

Table 1 shows the average length of the quiet periods and average number of active minutes per hour in the night sleep of the four younger infants, for whom continuous night records were taken at the Civic Home during the periods specified No consistent age differences were present

Figure 3 shows the average number of active minutes per hour for all nine subjects. The most quiet hour is the second hour. The increase in activity at the fourth hour and the subsequent decrease

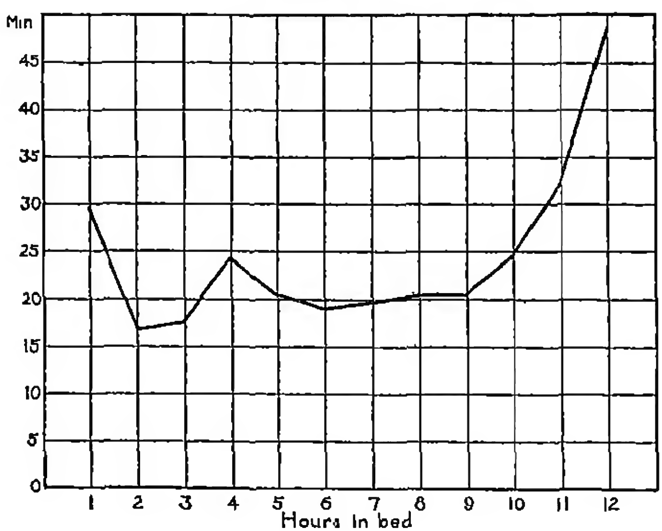

FIGURE 3
AVERAGE NUMBER OF ACTIVE MINUTES PER HOUR IN NIGHT SLEEP
(All Subjects)

during the next two hours is accounted for by the 9:00 o'clock feeding period at the fourth hour

The immediate effect of food on activity was to diminish it. In the case of a few infants whose 1.00 A.M. feeding was omitted during the time of the experiment, activity increased as previously at the hour of feeding for a few days. This effect, however, was only temporary.

Postures and Movements in Day Naps

General body postures during the day naps for the year as a whole occurred in the following ratios:

Dorsal posture	66%
Prone posture	14%
Left-side posture	10%
Right-side posture	10%

A gradual but consistent change in type of posture occurred with age Although dorsal posture exceeded any other single posture at every age, it decreased from 97% at 8 weeks to 35% at 52 weeks Prone posture was found only once before the age of 32 weeks, but occurred at every age level from that time on. No significant age changes in incidence of right- or left-side posture were present. This order of frequency in postures assumed by sleeping infants is in direct contrast with that found by Boynton and Goodenough (1) in nursery-school children, their frequencies being 31.1% for right-side posture, 29 1% for left-, 26 9% for prone, and 12.9% for dorsal.

Individual characteristics of sleep posture were prominent in only two infants. C B. slept predominantly on his right side at the early age levels when most infants assumed the dorsal posture, B.W. was the first to assume the prone posture, and showed a higher incidence of this posture than any other infant from that time on.

Head postures occurred in the following frequencies.

Right position	45%
Left position	30%
Middle position	23%
Prone position	2%

No consistent age differences were present.

Arm postures The most predominant arm posture (44%) consisted of flexion of both arms at the elbow, with abduction at the

shoulder so that the arms rested above shoulder level with forearms more or less parallel to the sides of the head, and hands loosely fisted. Twenty-one per cent (21%) of all arm postures were flexion at the elbow with less abduction at the shoulder, so that the arms rested below shoulder level. Next in frequency were variations of the two above postures, namely right arm flexed above shoulder level with left arm flexed below (7.1%), and left arm flexed above shoulder level with right arm flexed below (7.0%) Other variations occurred in very small percentages, with extension seldom present. In general, the following were the most outstanding features of arm posture: bilateral, symmetrical arm postures predominated (72.9%), flexed postures greatly exceeded extended postures (64 8%, both arms flexed; 27 5%, one arm flexed); above-shoulder postures had a higher frequency than below-shoulder postures (46 2%, both arms above; 19.2%, one arm above), when the two arms assumed asymmetrical positions, right-arm extension (2.8%) exceeded left-arm extension (2.2%), and positions of right arm below shoulder (7.4%) exceeded those of left arm below shoulder (6 3%) The last named fact was more prominent in the last six months, when right-arm extension had a frequency of 2.8% as compared with 1 8% for left, and when right arm below shoulder had an average frequency of 9.8% as compared with 8.2% for left. Comparison of other arm postures of the first six months with those of the last six months revealed the following facts Postures in which one or both arms were extended at the elbow showed a frequency of 18 8% in the first six months as compared with 22.8% in the last six. Postures in which one or both arms were below shoulder level showed a frequency of 42 6% for the first six months as compared with 65.6% for the last six. Similarly, bilaterally symmetrical postures decreased from 77 5% during the first half year to 68 2% in the last half.

Little direct manifestation of the tonic neck reflex was present at even the lowest age levels This reflex is found in response to spontaneous head turning in normal infants who are awake and relatively unrelaxed. It disappears at about the age of 16 weeks Under the existing conditions of observation, few consistent tonus changes in sleep were noted in either the ipsilateral or contralateral limb when the infant turned its head in either direction However, one fact resulting from the analysis of arm postures may have some

relation to the tonic neck reflex. Percentages of asymmetrical arm postures for each successive quarter of the year were as follows: 3.2%, 1.8%, 2.5%, 4.7%. The higher percentage of asymmetry of the arms at the 8-, 12-, and 16-weeks levels may possibly be the result of some form of the tonic neck reflex. Increasing asymmetry in the latter part of the year, on the other hand, is more probably a function of increasing differentiation of response mechanisms. The lack of more direct manifestation of the reflex at the lower age levels may find its explanation in the fact demonstrated by Lee and Kleitman (14), Tuttle (21), Jacobson and Carlson (8), and others, that tonus is much diminished in sleep.

Movements in sleep were divided into two groups: those which resulted in a definite posture change which persisted for more than one minute, and those which did not necessarily result in posture change. The movements which led to changes in sleeping posture were distributed as follows: head, 25.7%; right arm, 14.4%; left arm, 12.3%; both arms simultaneously, 10.1%; legs, 4.8%; head and arms simultaneously, 4.8%; head and left arm, 3.9%; head and right arm, 3.3%, body as a whole, 2.6%; others averaging 1.1% each.

The distribution of frequencies is different when those movements are considered which do not necessarily lead to persisting posture change. This group includes a large number of smaller body movements (facial, lid, finger, etc.) not included in the group above. The order of frequency is as follows:

Arm (extension, flexion, slashing, rubbing face)	24.5%
Eyelid (opening, closing, fluttering, tightening, partial closing)	18.2
Leg (kicking, extension, flexion)	14.7
Head	14.3
General body movements (squirming, back-arching, deep sighs, jerks, stretching, rolling)	10.0
Hand (flexion or extension at wrist, finger movements)	9.0
Mouth (lip or tongue movements, thumb-sucking, yawning)	6.6
Other facial movements (grimaces, smiles)	1.3
Miscellaneous	1.4

The most significant age change in this distribution was that some of the smaller movements showed a relatively greater increase than the larger movements. This change was not sufficient, however, to alter the order of frequency. Table 3 shows a comparison of the movements for the first and the last six months of the year.

Some interesting suggestions bearing on the development of right-handedness eventuated in the consideration of the distribution of

frequency of right- and left-arm and hand movement, and simultaneous movement of these members The data presented in this paper are *inadequate to give statistical reliability to the* results, but are very suggestive since the same trend appeared to some extent in all infants. Figures 4 and 5 show the distribution of arm and hand movements at each age level.

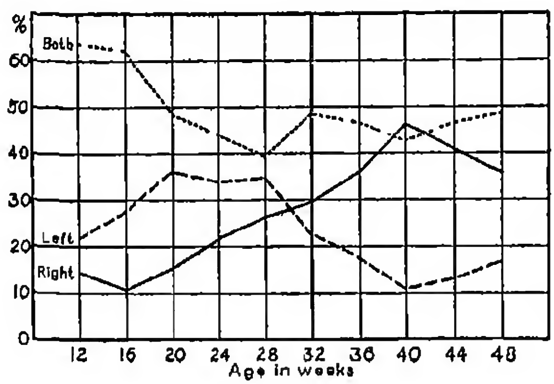

FIGURE 4

RELATIVE FREQUENCY OF LEFT, RIGHT, AND SIMULTANEOUS ARM MOVEMENTS IN DAY NAPS ACCORDING TO AGE

The curves have been smoothed by a moving average of three

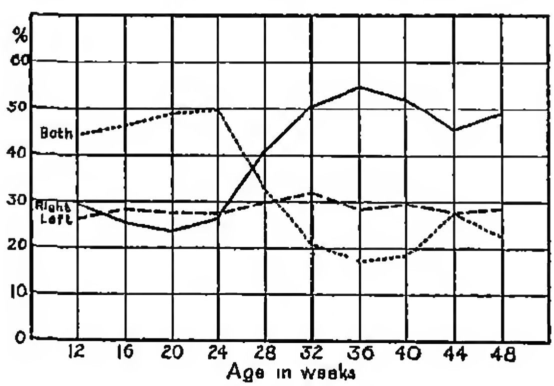

FIGURE 5

RELATIVE FREQUENCY OF LEFT, RIGHT, AND SIMULTANEOUS HAND MOVEMENTS IN DAY NAPS ACCORDING TO AGE

The curves have been smoothed by a moving average of three

TABLE 3

COMPARISON OF THE PERCENTAGE FREQUENCY OF MOVEMENTS FOR THE FIRST AND LAST HALF OF THE FIRST YEAR

Age	Arm	Lid	Leg	Head	Body	Hand	Mouth	Face	Misc
8-28 weeks	29 8	18 4	15.1	12 2	9.1	7 0	4 9	1.3	2.2
32-52 weeks	19 2	18.0	14 3	16 6	10 8	9 0	8.3	1 4	2.4

Figure 4 shows that simultaneous movement of the arms exceeds isolated movement at every age except 40 weeks; that left-arm movements exceed right-arm movements up to 32 weeks, and that the reverse is true from 32 weeks on. The drop in relative frequency of right-arm movements at 44 and 48 weeks may be due to the fact that at 48 weeks there were fewer arm and hand movements than at any other age Figure 5 shows not only that the predominance of right-*hand* movements in the last part of the year is even greater than that of the *right-arm*, but that this predominance begins earlier. Left-hand movements do not show the same high frequency at the earlier age levels as do left-arm movements This may be explained by the fact that at the early age levels, the hand, in waking behavior, tends to move as extensions of the arm and shows less independent motility. Movement of the arms, as described above, was independent of head or general body postures [4]

Discussion of Results

Although the number of cases studied in the present experiment is small, the results are so consistent from one infant to the next that statistical reliability is achieved. The data confirm in general several theories concerning the nature of sleep and concerning the general developmental sequence of behavior in animals.

First, the present study extends at the lower level the age-series studies on amount of activity in night sleep. Table 4 presents this genetic series as derived from results secured by various investigators. This lends support to the statements of Kleitman (12) and Szymansky (21) that the habit of night sleep is something which must be developed Sleep in infants is a great deal less sound than in adults or older children, if amount of activity can be taken as a criterion of soundness of sleep. Infants not only stir much more frequently, but

[4]The theory of the ontogenetic precedence of left-side dominance over right has been proposed by Professor Max F Meyer (14*a*, p. 203)

TABLE 4
AMOUNT AND DISTRIBUTION OF ACTIVITY IN DAY AND NIGHT SLEEP ACCORDING TO AGE

Age	No subj	Av. length quiet periods	Standard deviation	Av. no. active minutes per hour	Investigator
			Night sleep		
3-40 weeks	8	4 90	0.5	24.4	Marquis
2-3 years	7	8 17	1 57		Garvey* (6)
3-4 years	17	7 89	1.38		"
4-5 years	8	8.30	1 25		"
6-11 years	21	12 9	3.68	6 6	Renshaw, Miller, and Marquis (16)
11-13 years	23	10 4	2 71	8 3	"
13-15 years	17	9 4	1.65	9.5	"
15-18 years	19	9 8	2.09	8 8	"
			Range		
College students		12.8†	7.3–21 5		Johnson* (9)
Middle-aged men		9 0†	6 3–12 5		"
Wives of middle-aged men		10 5†	7 5–14 4		"
			Day sleep		
8-52 weeks (morning naps)	9	7 8	1 7	10.5	Marquis
2-4 years (afternoon naps)	56	25 3			Boynton and Goodenough (1)

*The data of the present experiment can be compared directly with those of Renshaw, Miller, and Marquis for older children, since the method of recording was equivalent A slight discrepancy between these studies and those of Johnson and Garvey may reside in the fact that the five-minute interval, with statistical correction, was used as the unit of measurement by the latter.

†"Most typical sleeper."

the length of time between their stirs is much less. Since the variation in amount of activity from night to night in infants' sleep is so small, we can conclude that the sleep of infants is much less variable than that of adults, since Johnson has found that a minimum of three weeks' sleep is necessary to secure a statistically reliable average for activity in an adult's sleep (9, 10).

The shape of the curve of activity of infants during the night sleep corresponds closely with those described by the authors cited in

Table 4 and others (13, 15), for older children and adults, allowing, of course, for the increased activity incidental to the 9·00-o'clock feeding period No evidence was found for a period of "sound sleep" just before waking such as that described by Czerny (2) on the basis of his measurements with the galvanic current.

Secondly, the data on sleep postures are a further indication that during the first year considerable maturation is reflected in the changes in simple body postures and movements. The evidence confirms in general the formulations of Coghill (3, 4) and others (5, 18, 19, 23) of an antero-postero gradient and a proximal-distal gradient in the development of behavior pattern. The antero-postero gradient expresses itself here in the facts that head and arm movement always exceeded leg movement and that the transition from bilaterally symmetrical to isolated movements of the limbs appears earlier and more completely in the arms than in the legs. Further evidence for this gradient may lie in the fact that, although head and leg movement are approximately equal when movement is considered without regard to resulting posture change, head movement predominates when a definite posture change results This may be interpreted by the fact that a higher degree of tonus is necessary for assumption and maintenance of a new posture than for simple movement with no resultant posture change. Further evidence that this probably represents anterior dominance at this age level is brought out by comparison of posture changes of the infants in this study with those of the two- to four-year-old children observed by Boynton and Goodenough (1). At the latter age, changes in posture of one or both legs greatly exceeded head changes in the ratio of 22.8% to 6.5% The chief point in favor of a proximal-distal gradient is the fact that the frequency of smaller movements (hand, mouth, face) increased with age at the expense of larger movements.

The process of differentiation of behavior pattern was also in evidence in the study of sleep postures and movements during the first year. This was seen especially in arm and hand movements. Bilateral and simultaneous movements of these members usually exceeded unilateral movements, but the latter increased with age. In cases where unilateral movement of an arm did occur, it occurred more frequently in the right than in the left. This extends the observations made by Irwin (7) on infants during the first ten days of life, in which he noted increasing differentiation with age of

smaller units of behavior from the more generalized and undifferentiated pattern of activity present at birth.

SUMMARY

A study was made of the amount and distribution of activity in night and day sleep and of the sleeping postures in day naps of infants under the age of one year. Thirteen normal infants served as subjects. The morning naps of nine of these infants were studied at intervals of four weeks throughout the first year A week's night sleep, at intervals of approximately four weeks, was studied for four of the above infants at the ages of 20 or 24 to 36 or 40 weeks. Continuous record was made of the night sleep of four additional infants all under the age of 23 weeks Record of sleep activity was made by means of automatic registration of sleep movements Postures and movements in day naps were observed by the experimenter and recorded on the same record.

The following are the most outstanding results of the study:

1 The average length of the quiet periods for *day naps* in nine infants during the first year was 7.8 minutes, for *night sleep* in eight infants, 4.9 minutes The average number of active minutes per hour for day naps was 10 5; for night sleep, 24.4. Day naps as a whole are therefore much quieter than night sleep These values have statistical reliability

2. Day naps become progressively quieter both in average length of the quiet periods and in number of active minutes per hour during the first year With four infants whose day and night sleep was studied during the period from 20 to 40 weeks of age, night sleep became more active and day sleep more quiet with age

3 In day naps the most quiet sleep occurred during the first half hour after the infant "went to sleep," activity increasing gradually from this time until waking. In night sleep, the most quiet period occurred the second hour after retiring. Increased activity attended the 9:00-o'clock feeding period. This was followed by a relatively quiet period of several hours duration, after which activity steadily increased to the hour of waking

4 There were no consistent age differences in the length of time required to "go to sleep." Infants usually fell asleep (i.e., became quiet with eyes closed for one minute or more) within 5 or 10 minutes after being put to bed.

5. Infants' sleep is much more active than that of older children or adults, and is less variable from night to night.

6. Dorsal posture exceeded any other body posture throughout the first year, but decreased with age. Postures became more variable toward the end of the first year.

7 Head turned to the right was the most frequent head posture throughout the year, followed by left, center, and prone in the order named.

8. Bilateral, symmetrical positions of the arms predominated, with a high incidence of flexion at the elbow and abduction at the shoulder so that above-shoulder positions were more frequent than below-shoulder positions. When the two arms assumed asymmetrical positions, the right arm deviated slightly more than the left from the usual postures (i e., assumed extended or below-shoulder postures). Below-shoulder postures, asymmetrical postures, and extended postures became more frequent toward the end of the first year.

9 The most frequent posture change was in head posture. This was followed by change in right and left arm in about equal proportions. Posture change of the legs was almost always bilateral and symmetrical. Posture change of each arm separately exceeded bilateral change of arm posture. Similarly, when posture change of various members of the body occurred simultaneously, change of head and arms together was most frequent. This exceeded change of head with a single arm, or of head with any other single member When other simultaneous changes of posture occurred, they usually involved the whole body.

10. The only evidence found for the presence of the tonic neck reflex at early age levels was the higher frequency of asymmetrical arm postures at the 8-, 12-, and 16-weeks levels than in the six months following.

11. When the frequency of sleep movements was computed regardless of resulting posture change, arm, lid, leg, and head movements occurred in the order of frequency named. The most prominent age difference was in the decrease in frequency of movements of the larger body members with corresponding increase in movements of the smaller members.

12. Left-arm movements exceeded right-arm movements from 12 to 32 weeks, and right-arm movements exceeded left-arm movements from that time on. Simultaneous movements of the arms exceeded movements of either arm at almost every age. Hand

movements showed the same general trend, with an even greater right-hand dominance beginning at 28 weeks. Left-*hand* movements did not attain the dominance attained by left-*arm* movements. Simultaneous hand movement occurred only rarely after the beginning of right-hand dominance.

13 Sleep postures and movements present further evidence of antero-postero and proximal-distal gradients of behavior development, and of a continued differentiation of pattern of behavior which extends throughout the first year

References

1 Boynton, M A, & Goodenough, F L The postures of nursery school children during sleep *Amer. J. Psychol.*, 1930, **42**, 270-278

2. Czerny, A Beobachtungen uber den Schlaf im Kindesalter uber physiologischen Verhaltnisse *Jahrb f Kinderhk*, 1891, **33**, 1-28.

3 Coghill, G E. Individuation versus integration in the development of behavior *J. Gen Psychol*, 1930, **3**, 431-434.

4 ——— The early development of behavior in Amblystoma and man *Arch. Neur & Psychiat.*, 1929, **21**, 989-1009

5. Coronios, J D The development of behavior in the fetal cat *Psychol Bull*, 1931, **28**, 696-697

6 Garvey, C. R. The activity of young children during sleep (Dissertation, Univ Minn, 1930) *Proc 9th Int Cong Psychol*, New Haven, 1929, 176-177

7 Irwin, O C The amount and nature of activities of newborn infants under constant external stimulating conditions during the first ten days of life *Genet Psychol Monog*, 1930, **8**, 1-92

8 Jacobson, E, & Carlson, A J The influence of relaxation on the knee jerk *Amer J Physiol.*, 1925, **73**, 324-328

9 Johnson, H M Sleep In *Readings in experimental psychology*, ed by W. L Valentine New York. Harper, 1931. Pp. 241-291

10 Johnson, H M, & Weigand, G. E. The measurement of sleep *Proc. Pa Acad Sci*, 1927, **2**, 43

11 Kleitman, N Sleep *Physiol Rev*, 1929, **9**, 624-665.

12 Kleitman, N, & Camille, N The role of the cerebral cortex in diurnal sleep in dogs *Amer J Physiol*, 1931, **97**, 537

13. Kohlshutter, E Messungen der Festigkeit des Schlafes. *Zsch f rationelle Med*, 1862, **17**, 209-253

14 Lee, M A M, & Kleitman, N Studies on the physiology of sleep: II Attempts to demonstrate functional changes in the nervous system during experimental insomnia *Amer J Physiol.*, 1923, **67**, 141-152

14*a*. Meyer, M F Psychology of the other-one Columbia Mo Book Co, 1921 Pp 439

15 Monnighof, —, & Piesbergen, F Messungen uber die Tiefe des Schlafes *Zsch f Biol*, 1883, **19**, 114-128

16 RENSHAW, S, MILLER, V., & MARQUIS, D. P Children's sleep New York. Macmillan, 1933 (in press)

17 SHERMAN, M. The afternoon sleep of young children *J. Genet Psychol*, 1930, 38, 116-125.

18 SHIRLEY, M The sequential method for the study of maturing behavior patterns *Psychol Rev*, 1931, 38, 507-528.

19. SWENSON, E A The active simple movements of the albino rat fetus *Anat Rec*, 1929, 42, 40

20 SZYMANSKY, J S Aktivitat und Ruhe bei Menschen. *Zsch. f angew Psychol*, 1922, 20, 192-222

21 ———. Versuche uber die Aktivitat und Ruhe bei Sauglingen *Arch f. d ges. Physiol*, 1878, 15, 573-574.

22 TUTTLE, W W The effect of sleep upon the patellar tendon reflex *Amer J Physiol*, 1924, 68, 345

23. WINDLE, W. F, & GRIFFIN, A M. Observations on embryonic and fetal movements of the cat. *J. Comp Neur.*, 1930, 52, 149-188.

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UNE ÉTUDE DE L'ACTIVITÉ ET DES POSTURES DANS LE SOMMEIL DES PETITS ENFANTS

(Résumé)

On a fait une étude de la quantité et de la distribution de l'activité dans le sommeil de la nuit et celui de la journée et des postures pendant le sommeil des petits enfants âgés de moins d'un an dans leurs sommes de la journée On a constaté que le nombre moyen de minutes actives par heure dans les sommes de la journée a été de 10,5, dans le sommeil de la nuit, de 24,4 La durée moyenne des périodes tranquilles des sommes de la journée a été de 7,8 minutes, celle du sommeil de la nuit, de 4,9 minutes. Les sommes de la journée sont devenus plus tranquilles d'une façon marquée pendant la première année, et il y a eu quelques témoignages que le sommeil de la nuit est devenu plus actif pendant cette période. Le sommeil des petits enfants est beaucoup plus actif que celui des enfants plus âgés et celui des adultes, et est moins variable de nuit en nuit

Les postures pendant le sommeil et les mouvements présentent des témoignages de gradations antéro-postérieures et proximales-distales dans le développement du comportement, et d'une différentiation continue des unités discrètes du comportement pendant la première année. La fréquence des changements de posture a été la plus grande à la tête, moins grande aux bras, et la moins grande aux jambes Les changements de posture des jambes ont été le plus souvent unilatéraux. Au-dessous de l'épaule, les postures non symmétriques et étendues des bras ont été plus fréquentes vers la fin de la première année.

MARQUIS

EINE UNTERSUCHUNG DER TATIGKEIT UND DER LAGEN IM SCHLAFE BEI SAUGLINGEN

(Referat)

Es wurde eine Untersuchung gemacht an dem Anzahl und der Verteilung der Tatigkeit wahrend des Schlafes bei Nacht und bei Tag, und der Lagen (postures) wahrend des Tageschlafchens bei Sauglingen die weniger als ein Jahr alt waren Man fand, dass es wahrend der Tageschlafchen durchschnittlich 10 5 Minuten Tatigkeit per Stunde gab, und wahrend des Nachtschlafes 24 4 Minuten per Stunde. Die durchschnittliche Lange der *Perioden der Ruhe wahrend der Tageschlafchen betrug 7 8 Minuten und* wahrend des Nachtschlafes 4 9 Minuten. Die Tageschlafchen wurden im Laufe des ersten Jahres bestimmt ruhiger, und man fand einigen Beweis dafür, dass der Nachtschlaf im Laufe dieser Periode aktiver wurde Der Sauglingsschlaf ist viel aktiver, als der Schlaf älterer Kinder oder Erwachsener, und ist von einer Nacht auf die andere weniger variabel.

Die Schlaflagen und Bewegungen erteilen Beweis fur antero-posterale und proximal-distale Gradiente der Entwicklung der Tatigkeit, und fur eine fortsetzende Differenzierung abgesonderter Tatigkeitseinheiten (differentiation of discrete behavior units) im Laufe des ersten Jahres Die Haufigkeit der Lagewechselungen war im Kopf am grossten, in den Armen am nachst-grossten, und in den Beinen am geringsten Lagewechselungen der Beine waren meistens zweiseitig und symmetrisch, aber Lagewechselungen der Arme waren meistens einseitig Von den Schultern nach unten wurden asymmetrische und ausgedehnte Lagen der Arme gegen Ende des ersten Lebensjahres haufiger

MARQUIS

TWIN RESEMBLANCES IN MOTOR SKILLS, AND THE EFFECT OF PRACTICE THEREON*[1]

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QUINN MCNEMAR

I. THE PROBLEM AND EXPERIMENTAL PROCEDURE

1 *Statement of the Problem.* Although the scientific study of mental inheritance began as early as 1869, and although a voluminous literature on the subject now exists, few data are available on the specific problem of heredity and environment as determiners of individual differences in motor abilities. It is the purpose of this paper to present the results of an investigation on the inheritance of the abilities involved in certain performances requiring skill.

The research to be described deals with the comparative resemblance of identical and fraternal twins and with the effect of practice on twin resemblance. Genetically, the two individuals of an identical pair inherit the same germ plasm, whereas the two individuals of a fraternal pair have similar but not identical heredities Individuals having the same hereditary origin should resemble each other in hereditary characteristics, but it does not follow from this that all traits in which identical twins show a high degree of resemblance are hereditary in origin. It is well known that identical twins have highly similar environments, a fact which has led some to attribute their resemblance in abilities to common environmental factors. The writer does not deny that there may ordinarily be a greater similarity in the environments of identical twins than in those of fraternals, but it seems to him highly improbable that the environmental difference of fraternal twins is sufficiently greater than that of identicals to account for a great amount of difference in the resemblance coefficients of the two.

To be more specific with regard to skills it may be said that insofar as the two individuals of a fraternal pair (like-sexed) have

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used the same toys, played the same games, and attempted the same "stunts," they have had an equal opportunity to develop muscular skill. Some investigators have assumed that the environments of fraternal twins are not more different than the environments of identicals, but it is here assumed merely that the difference is small in comparison with the difference in resemblance of the two types of twins In fact, the part of the study dealing with practice effects rests on the hypothesis that intra-pair differences may be due to environment and that practice of an equal amount would tend to wipe out such differences as are the result of environment. If, on a particular performance, practice raises the fraternal resemblance to that of identicals, it can be argued that this trait or ability is greatly influenced by nurture If, on the other hand, practice does not increase twin resemblances, it may be inferred that the differences are probably due to heredity.

This study is based on motor abilities rather than on motor ability because the work of Seashore (17), Perrin (15), Garfiel (5), and others has shown that there are several more or less specific abilities instead of a general one For this reason, tests of several abilities have been employed in the present research, and it will therefore be possible to determine which of those studied show the greatest influence of environment.

2. *Apparatus and Technique.* It was necessary for the investigator to choose from the available tests of motor abilities those which would meet certain essential requirements First, the measure should have high reliability and objectivity of scoring. Secondly, its performance should not be irksome or fatiguing, but rather interesting and challenging to the subject Thirdly, the apparatus involved should be portable and easily set up Fourthly, no two tests measuring the same function should be included. Fifthly, it seemed desirable to include as part of the battery some tests adaptable to prolonged practice in order to facilitate the collection of the two types of data desired

A further word should be said about the selection of abilities or functions to be studied in that part of the investigation which deals with practice effects Obviously, they must be functions which show improvement with practice, and preferably rapid improvement at first, followed by an early flattening of the practice curve A consideration which is often overlooked in practice studies concerns a possible change in function with practice. For example, a digit-

symbol substitution test is at first a sensory-motor task, but with practice it becomes a memory-motor performance. If twins were practiced on such a test, any change in resemblance might be due to a change to another function for which twins show a different degree of resemblance.

The practical difficulty of scheduling appointments on successive days made it imperative that all the work with a pair be done in a single day, and this in turn necessitated the use of practice material of such a nature as to give a good practice curve within a short time.

The following tests were finally chosen for the experiment: (1) the Koerth pursuit rotor, (2) the Whipple steadiness tester, (3) the Miles' speed drill, (4) the Brown spool packer, and (5) card sorting. All of these have been used to measure ability, while the first, fourth, and fifth were used to measure practice effects. A complete description of the pursuit rotor, spool packer, and speed drill has been given by Seashore (16), and of the steadiness tester by Whipple (21), but card sorting as here used must be briefly described. The subject is required to sort by suit ordinary playing cards into a tray divided into four labeled compartments, 4½ by 5½ by ½ inches each. He holds a pack of 52 cards face down and these are turned up one at a time and tossed into the proper compartment with face up. The score is the number of cards sorted correctly in 30 seconds. Previous investigators working with card sorting have taken the time to sort a pack of cards as the score, but since in this experiment two subjects work simultaneously, it seemed desirable to hold time constant and thereby avoid any distraction which might be caused by one subject's finishing ahead of the other. The packs used were always well shuffled by the fan method.

Table 1 shows the number of trials and the order from test to test. Ten trials on the pursuit rotor were followed by four trials on the steadiness tester, etc. In all, seven cycles were used, the first three including all five tests, whereas for the last four the steadiness test and the speed drill were omitted. The first three cycles were given during the morning, beginning at about nine o'clock, and the last four were given after lunch, finishing at about three o'clock. The time for the first cycle, which includes time for directions and demonstrations of the performances, was about 60 minutes, for the second and third cycles, 45 minutes each, and for the last four cycles, 30 minutes each.

TABLE 1
SCHEDULE OF CYCLES AND TRIALS

Test	Length of trial	1	2	3	4	5	6	7
Pursuit rotor	20 sec.	10	10	10	10	10	10	10
Steadiness	3-15 sec	4	4	4				
Speed drill	10 sec	4	4	4				
Spool packing	60 sec.	4	4	4	4	4	4	4
Card sorting	30 sec.	4	4	4	4	4	4	4

Between cycles a rest period of a few minutes was given, but during a cycle the subjects were required to shift rapidly from one task to the next. (The lunch period varied from 45 to 75 minutes) The two individuals of a pair worked by turns on the pursuit rotor, steadiness test, and speed drill, but simultaneously on the spool packing and card sorting

3. *Instructions to Subjects.* After making notes necessary for diagnosis of identity, the following general directions or instructions were given:

> "The aim of these tests is to measure individual differences in skill of doing five performances and to see what the effect of practice will be on differences in performance. We wish to see whether twins are alike or not in their performances in such tests as we have here. You will be given your scores as we go along, and you will always be told how best to do each test, *so it is not a puzzle but a measure of accuracy* and speed of performance We will shift from one task to another as rapidly as possible, but you will have sufficient rest periods. Work as hard as you can just as you would in an athletic contest, and try to make each trial better than the last or previous trial It will be interesting to see which of you can get the higher scores, so if you wish to have a friendly race you may do so Remember that everybody makes rather low scores at first, but with practice you can improve your score"

The specific instructions for the pursuit rotor, speed drill, and spool packing followed those given by Seashore (16), and for the steadiness test those given by Whipple (21) For the card sorting the following instructions were given:

> "In this test you are to sort cards into four piles according to suits Hold the pack of cards like this (face down) turning up one card at a time and tossing it into its proper place face

> up. You are to see how many cards you can correctly sort in 30 seconds I will tell you when to start and when to stop If you make a mistake, just go right ahead, as mistakes will not be counted against you If a card drops on the table or floor, don't bother to pick it up Practice will improve your score"

It should be noted that all the required performances were demonstrated before the subject made his first trial. If a subject attempted to do a test by some novel method, he was corrected and again told the best way of obtaining a good score All the scores of a pair were placed on a record sheet which was available for inspection by the two subjects Thus each twin could follow his own progress on the tests, and also that of his brother.

4 *Motivation.* As in other testing and learning experiments in psychology, motivational factors cannot be ignored The writer believes that certain conditions in the present investigation have tended to produce a high degree of motivation In the first place, the two individuals of a pair were urged to compete with each other as though they were in an athletic contest or a game in which each tries to win over the other. It must be admitted that in some cases competition led to intense rivalry, but the few cases of extreme rivalry were easily handled by the experimenter in such a way that he believes no loss in efficiency resulted In the second place, since the subjects always knew their own standing and were urged to "beat" their previous scores, the factor of self-competition was introduced and it was gratifying to the experimenter to observe the value of this as an incentive In the third place, it was evident that the subjects were eager to obtain scores which would compare favorably with those of other boys, and thus competition of another type was brought into play.

These three factors, intra-pair competition, self-competition, and a type of competition against the scores of the group, appeared to be very efficacious motivational schemes. The experimenter was well pleased with the enthusiasm and cooperation shown by the subjects It might be expected that the twin having the lesser ability would tend to become discouraged, but it should be remembered that the nature of the tests was such that the poorer in one task was not necessarily poorer in the other tasks (Later it will be shown that the coefficients of intercorrelation are so low as to justify this statement.) In fact, the cases in which one individual was ahead in all five tasks were very few

Despite the claims just made for strong motivation, there were two pairs in whom the lack of motivation was so obvious as to make it inadvisable to include their results in the computations for either the resemblance or practice part of the study, and in the case of two other pairs the cooperation during the afternoon cycles was such as to make it advisable to exclude their results from the practice study The investigator admits that the throwing out of the records of these four pairs is a subjective matter, but he feels that the lack of motivation was so obvious that a second experimenter would have arrived at the same decision In the presentation of results, the scores of these four pairs (Nos 6, 14, 88, 97) will be given as a matter of record.

5. *Selection of Subjects.* Three factors influenced the decision to use only boy-pairs for this experiment first, sex as a possible variable would be ruled out, secondly, it was believed that in motor tests boys would be better motivated than girls; and thirdly, since a large part of the field work was to be done during the summer vacation, it was thought that it would be easier to persuade parents to allow boys to be taken away from home for a day in the laboratory It was decided to use twins of junior-high rather than high-school age for the following reasons. first, it was believed on *a priori* grounds that boys of junior-high-school age would be more cooperative, secondly, fewer junior-high-school boys work during the summer months; and thirdly, since the larger part of the field work was to be done during school months, it was felt that school authorities would be more willing to allow junior-high boys to miss a day of school Grade-school twins were excluded because it was feared they would be more subject to fatigue and therefore less easily motivated It should be noted, however, that some boys not in junior high school were included in the study because they had twin brothers who were One senior-high-school pair was also included in the study.

With the study limited to boy-pair twins of junior-high-school age, it became necessary to survey the junior high schools of several cities in order to locate the desired number of pairs (100 pairs was the goal of the study). To locate the twins, a brief circular was distributed among the teachers asking them to inquire for "any boy in the room who has a twin brother in the same room or in some other room, grade, or school" This method was used in all the cities surveyed except Oakland, where the director of research

TABLE 2
PAIRS LOCATED AND NUMBER COOPERATING

City	Number located	Number who cooperated	Blank refusal	Working, ill, vacation, etc
Fresno	9	9	0	0
Long Beach	9	8	0	1
Los Angeles	45	28	5	12
Oakland	20	17	3	0
Pasadena	9	6	0	3
San Francisco	35	26	8	1
San Jose	6	4	0	2
Totals	133	98	16	19

assured the writer that the counselors would know the location of all twins. Table 2 shows the result of the survey for the several cities and also the number of cooperating and non-cooperating pairs of twins therein.

The writer thought of checking the number located against the number of pairs which would be expected for the junior-high-school population surveyed (approximately 65,000) on the basis of the ratio of single to twin births, but this plan was abandoned because of lack of exact information concerning the greater infant mortality for boy twins, and because of complications resulting from the fact that in several cases only one twin of a pair was in junior high school. It is interesting to note, nevertheless, that the number located compares favorably with the number of boy-pairs, 130, located by Wilson and Jones (23) in their survey of the entire school population (75,000) of several cities

The field work for the various cities was done as follows: Fresno, during May; Los Angeles, Long Beach, and Pasadena, between June 26 and September 7, San Francisco, Oakland, and San Jose, September 27 to January 11. The number whose cooperation could not be secured because of working and vacation was naturally greater for the three cities worked during the summer months, whereas the greater number of refusals occurred when cooperation would have meant the missing of a day of school. Although the more different in intelligence are apt to be overlooked in a survey of this kind, it does not follow that those pairs would also show the greater difference in motor skills, since the average correlation of intelligence with the five motor performances is only .16. Whatever selection came

about as a result of failing to locate all the fraternal pairs would presumably tend to make the coefficients of resemblance for the fraternals higher than the true coefficients In the case of the identicals, it is doubtful whether there is any relationship between differences and being overlooked.

A second source of selection is the possible refusal of parents whose twins are markedly different from one another in their abilities. In the case of intelligence, this factor can be determined in part by comparing the IQ differences of those whose parents refused with the differences of those whose parents did not refuse In Table 3 will be found the average IQ differences for several groupings of the cooperating and non-cooperating twins (IQ data were not available for all pairs.) An examination of the results in this table shows that, when one extreme case showing a difference of 49 IQ points is omitted, there is little evidence of failure to secure cooperation being associated with intra-pair difference in IQ. The extreme case demands a little attention. When the investigator interviewed the mother of this pair, he soon noticed that she was supersensitive about her boys, and her refusal led him to believe that they might be markedly different Subsequent checking of school records revealed this large IQ difference The extent to which selection as a result of refusals or working, etc., has affected the coefficients of resemblance for motor abilities cannot be determined. The fact

TABLE 3
AVERAGE IQ DIFFERENCES FOR SEVERAL GROUPS

Group	*N*	Mean IQ diff
Cooperating pairs	90	8 1
Non-cooperating pairs	29	9.7
Non-cooperating, omitting extreme case	28	8 2
Non-cooperating because of work, etc	17	10 0
Non-cooperating because of refusal	12	9.1
Ditto, omitting extreme case	11	5 4
Cooperating fraternals	44	10 4
Cooperating identicals	46	5 8
Non-cooperating probably fraternals	15	12 3
Ditto, omitting extreme case	14	9 6
Non-cooperating probably identicals	8	5 8
Non-cooperating unclassified	6	8.2

that as many refusals were met with in the case of identicals (probable) as in the case of fraternals (probable) would indicate that factors other than dissimilarity were involved in the refusals. As noted, some refusals resulted from the desire of parents to keep the twins in school.

6. *Diagnosis of Identity in Twins.* Probably the greatest single difficulty to be met with in studying twins is that of the diagnosis of identity. If accurate birth records were always available, this problem would be much easier, but in the absence of information concerning the membranes at birth the investigator must turn to other criteria for classification. Many criteria have been used by investigators, all of whom admit that there is no one entirely satisfactory. There is, however, rather general agreement among students of twins that in the large majority of cases diagnosis is readily made. Newman (10), Siemens (18), Verschuer (20), and Dahlberg (3) are all of the opinion that diagnosis can be made with a high degree of certainty in all but a few cases. Klein (8) and Curtius (2), however, claim that certain classification is by no means easy. Newman (11) has recently made extensive claims for the use of finger prints, but the work of Komai (9), Wilder (22), and Cummins (1) throws some doubt on the value of the finger print method.

It appears therefore that although a large proportion of twins are easily classified, there remain a few pairs which can never be diagnosed with absolute certainty by any method or combination of methods at present available. In the present investigation, a scheme of diagnosis similar to that of Siemens (18) has been used, the Siemens method having been modified somewhat to include the salient points of similar schemes. The following criteria were used: (1) Eyes—color, iris pattern, lash color and length, and brows. (2) Hair—color, form, texture, distribution on forehead, temple, and neck. (3) Skin—color, texture, freckles, follicles, and blood appearance. (4) Mouth—form, lips, tongue grooves, and teeth. (5) Ears—size, shape, and lobes. (6) Other features—face form, nose, and chin. (7) Hands—form, fingers, and palm lines. (8) Finger prints in doubtful cases.

Following the above scheme, the investigator was able to diagnose with a fairly high degree of certainty 95 of the 98 pairs as being 48 fraternals and 47 identicals, the remaining three pairs being doubtful. It should be noted that the effect of wrongly diagnosed cases should be to raise the coefficients of resemblance for the fraternals

and to lower the identical coefficients, so that any conclusions drawn from the results of the resemblance part of this study must be modified accordingly.

7. *Statistical Considerations.* It is the purpose of this section to set forth the statistical procedures used in reducing the data. Such a discussion will indicate to the reader the statistical concepts employed, and will eliminate the necessity of interrupting the presentation of results with such explanations.

The reliabilities of the tests have been determined by the odd-even-trial technique and the Brown-Spearman formula. Although there is some question as to whether such a procedure gives reliability coefficients comparable to those obtained by the test-retest or form-versus-form method, the writer believes it to be the most satisfactory method of determining the reliability of scores affected by practice. By the use of odd-even trials, two sets of scores are obtained which are nearly comparable as regards practice effects, and which are more comparable as to means and standard deviations than any other set of scores obtainable from learning material. The reliabilities have been computed for the entire age range, and then the reliability for a single age determined by use of Formula 178, Kelley (7, p. 222). The standard deviation for a single age range for use in this formula corresponds to the standard error of estimate as determined from a knowledge of the correlation between age and performance.

The intercorrelations of the several variables have been computed by the product-moment method using the twins as individuals, and hence these correlations are based on twice as many cases as there are twin pairs in the study.

Correlations for twin resemblances have been computed from double-entry scatter diagrams in which Twin A is first entered as x and Twin B as y, then B as x and A as y. According to R. A. Fisher (4, p. 180) this gives a more accurate estimate of intra-class correlation than any other method. The correlation so determined, however, suffers from a slight negative bias, which, being small (less than .01) in comparison with the probable errors, has not been allowed for in this study. For n pairs such double-entry plots will contain 2 n entries, but the probable error of the resulting correlation coefficient is not based on a sample of 2 n. The advantage, as regards the probable error, is equivalent to 1½ additional pairs (4, p. 183).

The partial correlation technique has been used to render age

constant. Before computing the partial coefficients, the age-versus-performance scatter diagrams were carefully studied to be sure the relationships showed no curvilinear tendencies. All the intercorrelations and twin correlations reported in the chapter on results are partials, age being thereby eliminated as a variable.

Corrections for attenuation have been made and the corrected r's will be given along with the raw coefficients. Since there is some doubt as to whether the odd-even-trial reliability coefficients for material which involves learning are the proper ones to use to allow for errors of measurement, the principal analysis of the data does not depend upon the corrected coefficients. The probable errors of the corrected coefficients have not been determined because the corrected r's do not differ much from the raw coefficients, and have probable errors of approximately the same magnitude.

For the study of the effect of practice on twin resemblances it is necessary to show that the direction of results will be in agreement for time and attainment units, that is, that if a change in twin resemblance as a result of practice occurs when attainment scores are used, a similar change would also occur if time scores were used. The reciprocals of the attainment scores will be proportional to the time required to do a given amount of work at the rate indicated by the original (attainment) scores. Thus the rank order of individuals as determined from their attainment scores would not be altered by converting their scores to time units, and, if twin resemblance were determined by the rank-difference method, the coefficient for attainment units would be the same as that for time units. Furthermore, any change in rank order as a result of practice will be the same for either type of unit, so that, if practice increases (or decreases) twin resemblance when attainment scores are used, the same change would also be found if time units were used. Accordingly, it seems safe to infer that the product-moment method of correlation would also show agreement from unit to unit in regard to changes in resemblance (resulting from practice). It is not assumed, however, that the coefficients of resemblance based upon the two types of units would be exactly the same, but only that any change in resemblance as a result of practice would be in the same direction for both units. Empirical evidence will be presented later to show that the above inference is warranted.

The average intra-pair differences have been obtained by straightforward computation of the average difference regardless of the

direction of differences. An average difference is difficult to interpret without knowing what the average difference would be for individuals paired at random Since statisticians have not, to the writer's knowledge, determined this theoretical expected difference, psychologists have resorted to the computation of the average difference between scores drawn at random by pairs But by the use of such a procedure the theoretical expected average difference might not be obtained because of the sampling errors involved in the drawings. In an attempt to solve this problem, the writer has applied the elementary theories of probability to build up a distribution of differences for a million pairs drawn at random. Empirical determination of the average difference of this obtained distribution gave the theoretical average difference as 1.12837929+ times the standard deviation of the distribution of ability in a given trait Since 2 over root *pi* equals 1 12837916+, it can be said that the theoretical average difference for individuals paired at random is $2 \div \sqrt{pi}$ times σ. (The writer has a more rigorous analytical derivation which he hopes to publish shortly. By it he obtains the last given value above)

Other statistical concepts incidental to the use of the above mentioned procedures need not be discussed in detail here, but they will be given essential treatment at the time of their use in the following chapter on results

II. Results

This chapter on results is divided into four sections the first of which contains pertinent data on the distributions, age relationships, interrelations, etc , of the variables (based upon twins as individuals) The second section is devoted to the results of the study of twin resemblances stated in correlational terms, while the third section is concerned with intra-pair differences. The last section gives the findings for the effect of practice on twin resemblances All interpretations and conclusions will be reserved for the third chapter

1 *Distributions, Interrelations, etc* It will be recalled from Table 1 (schedule of cycles and trials) that the first cycle consisted of 10 trials on the pursuit rotor and four trails on each of the other four tests. The second and third cycles were the same as the first, while the remaining cycles omitted the steadiness tester and speed drill The scores used in the resemblance study, and consequently the scores for each test upon which the means, standard deviations, and interrelations presented in this section are based, represent the

sum of the scores earned on all the trials of the first three cycles. That is, the score on the pursuit rotor is the sum of the scores on 30 trials, etc.

Table 4 contains the means and standard deviations for the several variables for the two groups of twins separate and combined The fraternal group is superior on all five performances, but for only the last two, spools and cards, do the differences approach statistical significance With regard to variability, the differences for the steadiness and card sorting are nearly three times their standard errors. Since the coefficients of resemblance are greatly affected by the range

TABLE 4
BASIC CONSTANTS FOR GROUPS (NO ALLOWANCE FOR AGE)

Variable	Group	Mean	σ_m	SD	σ_{sd}	N
Pursuit rotor	Frat	2324	82	783	58	92
	Ident	2172	80	774	57	94
	Comb.	2247	57	774	40	186
Steadiness	Frat	230	19	182	13	92
	Ident	246	24	232	17	94
	Comb	238	15	209	11	186
Speed drill	Frat.	2490	22	207	16	92
	Ident.	2478	22	216	16	94
	Comb.	2484	15	211	11	186
Spool packing	Frat	761	8	79	6	92
	Ident	741	7	66	5	94
	Comb.	751	5	74	4	186
Card sorting	Frat	285	4	42	3	92
	Ident	275	3	31	2	94
	Comb.	280	3	37	2	186
Age (yrs.)	Frat.	14 31	13	1.25	09	92
	Ident	14 38	.13	1 28	.09	94
	Comb.	14 35	.09	1.27	07	186
Mental age*	Frat.	14 45	19	1 78	.13	88
	Ident	14 16	.22	2 05	16	90
IQ*	Frat.	102.1	1.4	13.4	1 0	88
	Ident.	99 6	1.6	15 2	1 1	90
MA†	Comb	14.56	16	1.77	11	120

*Includes T G T., N I T., and other tests.
†Terman Group Test only

TABLE 5

CORRELATIONS WITH AGE

	N	Pursuit	Stead	Drill	Spools	Cards
Frat.	92	339	254	510	243	367
Ident.	94	268	268	200	023	406
Comb	186	.299	259	347	.134	372

of ability in the groups, allowance will be made for differences in variability when the coefficients for identical twins are compared with those for the fraternals

The age distributions are nearly the same for the two groups, but for intelligence (mental age and IQ) the identical-twin distribution is slightly more variable as indicated by the larger standard deviations. The writer does not place much confidence in the use of the intelligence test data available for the twins of this study because of the variety of tests represented and because of possible errors in the school records from which the scores were obtained. The Terman Group Test scores, however, may be sufficiently reliable for a rough estimation of the relationship of the motor abilities herein studied to intelligence Consequently, the 120 individuals having Terman Group Test scores have been combined for this purpose, and the mean and standard deviation for this combined group are given at the bottom of Table 4 It should be noted that age as a variable has not been allowed for in reporting the standard deviations of Table 4.

The correlation of the motor abilities with age are given for reference in Table 5 (All other correlations reported in this study are for a single age, age having been held constant by partial correlation technique.)

In order to indicate the community of function between the tests herein used, the intercorrelations for the several variables are given in Table 6 These intercorrelations are somewhat higher than those reported by Perrin (15), Garfiel (5), and Seashore (17) for various motor functions, the difference probably being due to a difference in range or to a higher degree of motivation in the twin study. It will also be observed from this table that the correlations of the motor tests with intelligence are very low

2 *Twin Resemblances in Motor Skills.* Table 7 gives the reliability coefficients, twin-resemblance coefficients (uncorrected and

TABLE 6
INTERCORRELATIONS BASED ON 186 TWINS TAKEN AS INDIVIDUALS
Age constant Reliabilities are given in the diagonal

	Pursuit	Steadiness	Drill	Spools	Cards
Pursuit	.992				
Steadiness	.361	979			
Speed drill	511	.284	.973		
Spool packing	427	221	421	.960	
Card sorting	295	151	333	.409	.965
Terman Group Test mental age (N, 120)	17	04	37	.17	15

corrected for attenuation), and the standard deviations for the two groups—all with age constant. In all five performances, those twins diagnosed as identicals show a degree of resemblance which is higher than for those diagnosed as fraternals. It will be noticed that for all tests except the pursuit rotor there is a rather large difference in the range (S D) of ability, the identicals showing a greater range in two tests and the fraternals having the greater $S.D.$ in the other two.

As is well known, correlation coefficients are not comparable when *based on groups showing differences in range of ability. For example,* on the steadiness test the coefficient of resemblance for fraternal twins is lower than that for identicals for two reasons, namely,

TABLE 7
TWIN RESEMBLANCES IN MOTOR SKILLS, 46 FRATERNAL AND 47 IDENTICAL PAIRS
Age constant

Test	Group	Reliabilities	Twin r's	Corrected for atten	$S.D$ of dist of scores
Pursuit rotor	Frat	.991	503± 073	508	737
	Ident	.993	949± 010	956	746
Steadiness	Frat.	968	238± 092	.216	176
	Ident	.986	.854± 026	866	224
Speed drill	Frat	970	433± 079	.447	178
	Ident	.976	819±.032	.839	212
Spool packing	Frat	955	.485± 075	.508	77
	Ident.	.962	.615±.060	639	66
Card sorting	Frat.	973	498± 074	512	39
	Ident.	952	.731± 045	.767	29

greater intra-pair differences and lesser range (*S D.*) of ability. The difference between these two resemblance coefficients would be less if the ranges of talent were equal The same is true for the speed drill, but in the case of spool packing and card sorting equalizing the ranges for the two groups would tend in each instance to increase the difference between the resemblance coefficients for the two groups. In the light of the preceding discussion, it seems advisable to estimate what the correlations of resemblance would be if the range were the same for both groups of twins—a procedure which will yield resemblance coefficients which are more nearly comparable so far as range is concerned.

If the correlation between two variables is known for a given range in each variable, it is possible to estimate the correlation for different ranges in either one or both variables by methods derived by Pearson (12, 13)—methods which he in a later paper (14) has shown to be general, i e., not based on Gaussian-type distribution. Since neither of these formulas is applicable in the case of double-entry twin correlation, it was necessary to devise a method for adjusting the resemblance coefficients for differences in range. The difference formula, $r = 1—\sigma_d^{\,2}/2\sigma^2$, gives the correlation as a function of the variance of twin differences and of the total variance. If one can assume that the variance of twin differences is the same throughout the range, this formula can be used to derive an expression for the correlation in a range differing from the given range. A change in range affects the σ^2 factor, whereas the $\sigma_d^{\,2}$ factor remains unchanged Solving the difference formula for $\sigma_d^{\,2}$ gives $\sigma_d^{\,2} = 2\sigma^2\,(1—r)$, which by assumption will be the same for any range of ability. Back substitution leads to the following identity, $r = 1 - \dfrac{2\sigma^2(1—r)}{2\sigma^2}$ in which the numerator of the fraction is the variance of twin differences in terms of the given range of ability and of the correlation for this given range To estimate what the correlation, R, would be for a range with variance of s^2, the formula becomes $R = 1—\sigma^2\,(1—r)/s^2$ which gives the correlation for a different range in terms of the correlation for a given range and of the ratio of the variance of the given range to that of the second range Obviously, if s is larger than σ, the estimated correlation will

be higher than the original, but if σ is larger than s the reverse will be true. Furthermore, the estimated correlation, whether higher or lower than the original, does not indicate a greater or lesser degree of resemblance when resemblance is defined in terms of twin differences. If the fraternal and identical coefficients are adjusted to the same range, they are more comparable measures of resemblance than coefficients based on different ranges.

It remains to decide whether the coefficient based on the smaller range should be adjusted to that of the larger (or vice versa), or whether it would be better to estimate both coefficients for the range represented by the standard deviation obtained by combining the two groups. *The latter procedure seems the more reasonable* since the combined group will give the best estimate of the variability of motor test ability in boy-pair twins (taken as individuals) of junior-high-school age. *If either the fraternal twins or the identical twins were* the more variable group for all five tests, one might suspect that some selective factor was operating, but since this consistency is lacking, the writer feels that the *differences in variability are probably chance* differences. It should be noted that since correlations with age constant are desired, the adjusted coefficients are obtained by using the

TABLE 8

TWIN RESEMBLANCE COEFFICIENTS ADJUSTED FOR DIFFERENCES IN RANGE—THE EXPECTED CORRELATIONS FOR RANGE OF ABILITY EQUAL TO THAT OF THE TWO GROUPS COMBINED

Age constant.

Test	Group	Unadjusted twin r's	S.D for single groups	S.D for groups comb'd	Twin r's adjusted for range	Corrected for attenuation
Pursuit rotor	Frat	503	737	739	506	51
	Ident	949	746		948	.95
Steadiness	Frat	238	176	202	422	43
	Ident	.854	224		820	.84
Speed drill	Frat	.433	178	198	542	56
	Ident.	.819	212		792	.82
Spool packing	Frat.	.485	77	73	427	.44
	Ident	.615	66		685	.71
Card sorting	Frat	498	39	35	.377	.39
	Ident.	.731	29		815	.84

coefficients for constant age and the variances for a single age as the values to be substituted in the above formula.

Table 8 gives the unadjusted resemblance coefficients, the *S.D*'s for the two groups and for the groups combined, and the resemblance coefficients estimated for a range equal to that of the combined group This procedure makes little change in the coefficients of resemblance for the pursuit rotor, but for the steadiness test and the speed drill the coefficients for fraternals and identicals are brought nearer together, whereas the opposite occurs in the case of spool packing and card sorting The adjusted coefficients of resemblance given in Table 8 are comparable so far as range of ability and errors of measurement are concerned (comparable from group to group and not from test to test), so that any conclusions drawn therefrom need not be modified because of these factors.

3 *Intra-Pair Differences in Motor Skills.* Although an extensive analysis of intra-pair differences has not been made, the average intra-pair differences are given in Table 9 These averages are the means of the absolute differences. For a particular test the average intra-pair difference for identical twins may be compared with that of fraternals and the differences for both groups may be compared with the theoretical expected difference between individuals paired at random

Table 9 also contains the absolute intra-pair differences for the three pairs unclassified (as fraternal or identical) and the differences

TABLE 9

AVERAGE INTRA-PAIR DIFFERENCES AND DIFFERENCES FOR THE THREE UNCLASSIFIED PAIRS AND FOR THE TWO PAIRS OMITTED FROM THE GROUPS BECAUSE OF MOTIVATION

	Pursuit	Stead	Drill	Spools	Cards
Expected mean diff between individuals paired at random (1.128 x *S D*)	833	228	223	82	38
Frat twins (*N*, 46 prs)	569	155	149	62	31
Ident twins (*N*, 47 prs)	210	90	102	42	17
Pr No 2, unclassified	375	30	88	0	29
Pr No 28, "	793	87	125	46	47
Pr No 50, "	471	6	297	53	34
Pr No. 6, motivation (?)	25	31	400	274	40
Pr No. 14, "	1801	211	647	36	83

TABLE 10
MEANS AND STANDARD DEVIATIONS FOR THE SEVEN SEGMENTS OF THE PRACTICE SERIES

	Pursuit rotor Frat.	Pursuit rotor Ident.	Spool packing Frat.	Spool packing Ident.	Card sorting Frat.	Card sorting Ident.
Means:						
1	370	303	225.8	220.8	88.4	85.3
2	848	799	261.0	252.7	96.4	94.5
3	1105	1053	274.7	265.9	101.3	97.6
4	1131	1098	281.3	272.9	104.1	100.2
5	1307	1276	289.1	279.8	104.9	101.8
6	1367	1369	295.0	287.7	105.8	102.0
7	1437	1423	299.9	291.2	107.2	103.8
S D's.						
1	226	193	28.2	22.8	15.2	11.3
2	310	308	29.3	23.8	14.2	11.1
3	291	313	27.6	20.9	14.7	11.1
4	261	276	29.6	23.2	13.8	10.3
5	244	246	29.4	23.0	13.5	10.2
6	250	250	29.3	21.4	13.5	10.8
7	238	221	29.3	23.6	12.8	10.9

for the two pairs omitted from the resemblance study because of questionable motivation. The differences for the three unclassified pairs, when referred to the distributions of differences, give no indication as to whether these pairs are identicals or fraternals. They might fall in either category so far as resemblances in motor skills are concerned The lack of motivation on the part of one of the individuals in each of Pairs 6 and 14 is probably responsible for the large intrapair differences for these pairs on certain of the tests As previously stated, the lack of proper motivation in these cases was so obvious that the investigator felt justified in excluding their scores from the computations.

4. *The Effect of Practice on Twin Resemblances.* Before the data for the effect of practice on twin differences are given, it is necessary to give attention to certain considerations basic to those data. The reader will recall that the tests used for the practice study were the pursuit rotor, spool packing, and card sorting, and that the practice series was broken up into seven cycles or segments The total number of trials was 70 for the pursuit rotor and 28 each for the spool packing and card sorting. Initial ability has been defined for each test as the sum of the scores made on the trials of the first cycle, and final ability as the sum of the scores of the seventh

cycle. Since performance on all trials beyond the first is affected by practice, the initial scores herein used are not initial in the strictest sense. It is necessary, however, to take the sum of the scores on several trials in order to obtain measures of performance which are reliable. Final ability is final so far as this experiment is concerned, and is not final as regards the individual's ultimate capacity

The means and standard deviations, for the twins as individuals, for the practice series are given in Table 10. It will be noticed that the fraternals are superior initially and that they maintain their superiority on all three of the practice tasks, and it will be recalled that they were also slightly superior in steadiness and on the speed drill. The differences in the spool packing and card sorting, which are larger statistically, are about twice their standard errors, and therefore not conclusive evidence for a true difference between identicals and fraternals. The fact that the fraternals are also superior on the three other tests might be expected on the basis of the small general motor ability present as indicated by intercorrelations of the order of .34. The writer believes that these differences have little significance as regards the two groups.

When considering the initial and final coefficients of resemblance as given in Table 11, it should be remembered that the chief interest is in comparing the initial with the final coefficients for a particular group and not in comparing the two groups of twins for either initial or final This latter comparison is not justified unless allowance is made for the differences in range of ability for the two groups Comparison of the initial with the final coefficients in Table 11 shows that practice did not effect a change in the resemblance of the identical twins on the pursuit rotor or in spool packing, whereas an increase in the resemblance of the fraternal twins did occur for these two performances. Both groups show a slight decrease in resemblance in card sorting The difference between the initial and final coefficients of resemblance for the fraternals on the pursuit rotor is 157 ± 081, and for the spools the difference is 174 ± 079. It should be noted that the differences just given are between correlated measures (for the correlation of initial with final performance see Table 12) and that the correlation between the two correlation coefficients which is needed in determining the probable error of the difference has been obtained by using Formula 129, Kelley (7, p. 179)

TABLE 11

EFFECT OF PRACTICE ON TWIN RESEMBLANCES AS SHOWN BY FINAL AS COMPARED TO INITIAL CORRELATION, 45 FRATERNAL AND 46 IDENTICAL PAIRS

Age constant

		Reliabilities		Resemblances		Cor. for atten	
		Initial	Final	Initial	Final	Initial	Final
Pursuit rotor	Frat.	988	.978	444±.078	601±.063	.450	.614
	Ident.	974	972	.876±.023	.869± 024	899	894
Spool packing	Frat.	908	928	.375±.085	549± 069	.413	.592
	Ident.	904	.892	.561± 067	542± 069	620	608
Card sorting	Frat	909	902	.556± 068	485± 076	612	.538
	Ident.	871	865	.750± 043	707± 049	861	817

TABLE 12
CORRELATION OF INITIAL WITH FINAL ABILITY
Age constant.

	N	Pursuit rotor 1st 10 *vs* last 10 trials	Spool packing 1st 4 *vs* last 4 trials	Card sorting 1st 4 *vs* last 4 trials
Frat	90	643± 042	.720± 034	791± 026
Ident	92	671±.038	632± 042	718± 034
Comb.	182	650± 028	690± 026	754± 021

The observed changes in resemblance just discussed have been obtained by the use of attainment scores, and the writer has argued earlier in this paper that similar changes would result if time scores were used. To check this assumption empirically the reciprocal scores for fraternals for the pursuit rotor and spool packing, the two performances showing change, have been computed and used to determine changes in resemblance with practice These reciprocal scores will be proportional to the corresponding time scores, though not necessarily equivalent to those which would be obtained from an experimental set-up devised to give time scores. The results of this empirical check show for the pursuit rotor an increase in resemblance, when estimated time scores are used, from 342 to .536, and for spool packing an increase from .362 to 579—thus supporting the assumption that when practice effects on twin resemblances are determined, the two types of units will reveal changes of the same order of magnitude.

Since comparison of the initial with the final coefficients showed that practice had tended to increase fraternal twin resemblances slightly, the question arose whether this change in resemblance came about gradually or whether it occurred early or late in the practice series. For this purpose the resemblance coefficients for the pursuit rotor and spool packing for fraternals were computed for the intervening five segments of the practice curve. The resemblance coefficients for the fraternals on card sorting and for the identicals on all three of the tests were also computed for segments (or cycles) 2 and 6. Examination of the results of this further analysis, as set forth in Table 13, indicates that the larger part of the minor change in resemblance for fraternal twins on the pursuit rotor and in spool packing came during the earlier part of the practice series Certain irregularities, probably due to chance, are to be found in this table

TABLE 13
EFFECT OF PRACTICE ON TWIN RESEMBLANCES AS SHOWN BY CORRELATIONS FOR SUCCESSIVE SEGMENTS OF THE PRACTICE CURVE
Age constant

	1	2	3	4	5	6	7	Approx. P.E.'s
Fraternals:								
Pursuit	445	461	577	.558	.556	612	.601	07
Spools	.375	539	438	536	532	591	549	.07
Cards	556	.472				.454	.485	.07
Identicals:								
Pursuit	876	864				858	869	02
Spools	561	573				519	542	.07
Cards	.750	.741				618	.707	05

It is necessary to consider at this place the data for the two pairs whose scores were not used in the practice study because of poor motivation during the last four cycles. In the case of pair No. 88 (fraternals, Twin B being very unstable since seeing his father commit suicide) the difference on the pursuit rotor for the initial cycle was fourth smallest in the distribution of fraternal intra-pair differences, whereas for the final cycle their difference was the largest. For the spool packing their difference decreased slightly, and for card sorting it increased slightly with practice. For pair No. 97 (identicals, A easily discouraged) the differences for the initial cycle on all three tests were exceeded by approximately 90% of intra-pair differences for identicals, but for the final cycle the differences for this pair on each of the three tasks were exceeded by only about 15%, which shows that a marked increase in differences occurred (probably as a result of motivational difference)

III. SUMMARY AND INTERPRETATIONS

It has been the purpose of the present research to study the inheritance of certain traits hitherto neglected by the students of heredity. A survey of the literature revealed few data which permit of any conclusions concerning whether there is or is not an hereditary basis for motor skills. Some individuals are regarded by their fellows as being awkward by nature, while others are said to have natural skill. Such conclusions by the layman, however, have no scientific value beyond that of suggesting a field for research—a field which should yield invaluable results for educational practice, vocational

guidance, and personnel management. This investigation has sought to throw light on the inheritance of certain performances involving muscular coordinations by ascertaining the relative resemblance of fraternal and identical twins, and by determining the effect of a limited amount of practice on twin resemblances.

1 *Summary of Experimental Procedure.* In order to locate subjects for this investigation, a survey of the entire junior-high-school population of the following cities was made: Fresno, Long Beach, Los Angeles, Oakland, Pasadena, San Francisco, and San Jose In all, 133 pairs of male twins were located, and of this number the cooperation of 98 pairs was secured. By using a classification scheme similar to that of Siemens (18), the 98 pairs were diagnosed as 47 identical and 48 fraternal pairs, the remaining three pairs being undetermined

The performances measured involved the following types of functions: (1) accuracy of eye-hand coordination in following a target moving in a circular path at high speed as measured by the Koerth pursuit rotor; (2) steadiness of motor control of arm, hand, and fingers as measured by the Whipple steadiness tester; (3) speed of rotary arm, wrist, and finger movements in turning a small hand drill (Miles' speed drill); (4) speed and accuracy in a bimanual coordination measured by the Brown spool packer, (5) speed of discrimination and serial reaction as measured by card sorting.

Each pair spent a day, from about 9 A M to 3 P.M., with the experimenter in the laboratory, during which time they were given several series of trials on each of five tasks. The two individuals of a pair worked under exactly the same conditions, taking alternate trials on each of the first three tasks and working simultaneously on the last two Excellent motivation was secured by stressing intra-pair competition and by urging each to "beat" his own record. (Because of poor motivation, two pairs were omitted from the resemblance part of the study and two additional pairs from the practice part.)

The statistical analysis of the data has involved. the use of partial correlation technique as a method of holding age constant, the determination of resemblances from double-entry scatter diagrams; allowance for differences in range of ability by estimating the resemblance for a single range—that of the entire group of 186 individuals measured, allowance for errors of measurement by correcting for attenuation, and determination of average intra-pair differences for each performance for each group.

2. *Limitations.* The chief limitations of this research are two: selection and errors of diagnosing identity. In any attempt to locate twins, those fraternal pairs most different in physical appearance are more apt to be overlooked as are also those pairs most different in intelligence. The first of these selective factors may or may not be correlated with differences in motor skills, but the second is not, since these skills show no appreciable correlation with intelligence. Errors in diagnosing should result in lowering the resemblance coefficients for identicals and in raising those for fraternals. These two sources of error, to the extent that they have entered, are of such a nature as to decrease the difference between the coefficients of resemblance for the two types of twins

3. *Summary of Findings.* The data on twin resemblances in motor skills are summarized in Table 14, wherein are also given coefficients for other traits. An outstanding fact in this table is the marked paralleling of the coefficients for skills with those for physical traits and intelligence. It is true, however, that those for motor skills are not quite so high as those for anthropometric measurements, a finding which is explicable on the basis of larger errors of measurement in the case of skills, these errors not being adequately allowed

TABLE 14

SUMMARY TWIN RESEMBLANCES IN MOTOR SKILLS COMPARED WITH RESEMBLANCES IN OTHER TRAITS

Age constant and r's corrected for attenuation

		Frat	Ident
This investigation.	Pursuit rotor	.51	95
46 frat pairs	Steadiness	43	83
47 ident. "	Speed drill	56	82
	Spool packing	44	71
	Card sorting	39	85
From Holzinger (6).	Tapping ability	.43*	78*
52 frat pairs	Binet mental age	67†	95†
50 ident. "	Height	.65	93
	Weight	63	.92
	Head length	.58	91
	Head breadth	55	.89
	Cephalic index	.58	.90
From Stocks (19)	Height	.49	.95
50 (?) prs. each	Weight	.44	.94

*Reliability of 88 assumed by present writer.
†Reliability of 90 assumed by present writer.

for by corrections for attenuation involving reliability coefficients computed by the odd-even-trial technique. Nevertheless, the differences between the coefficients for fraternals and identicals are of the same order of magnitude for motor abilities as for physical traits. Furthermore, the order of resemblance is the same for those three skills (pursuit rotor, steadiness, and spool packing) wherein the individuals have had no chance for specific practice, as for the two tasks (speed drill and card sorting) which may have been affected by some previous practice in similar performances. It is also interesting to note that the resemblances found for intelligence and skills are strikingly similar.

As to the part of the study dealing with the effect of practice on twin resemblances, it was found that practice increased fraternal twin resemblances on the pursuit rotor from 45 to 61, and in spool packing from 41 to 59, the increase in each instance being twice its probable error The fraternal resemblance in card sorting and the identical resemblance for all three performances changed very slightly with practice In the practice study it was shown that consistent results can be obtained regardless of whether the scoring units are expressed in terms of attainment in constant time or as time for constant work, thereby demonstrating the feasibility of studying nature-nurture effects on specific traits by giving twins equal training

4. *Interpretations and Conclusions* It is indeed striking that twins diagnosed solely on the basis of physical resemblance should show nearly the same divergence in resemblance coefficients for fraternals and identicals in the case of traits requiring muscular coordination or skill as in the case of anthropometric measurements To say that these results are artifacts of the experimental procedure one must assume (1) that the two members of an identical pair tended to work at the same rate, i e, that the superior allowed his brother to keep pace with him, and (2) that this factor operated to a much less degree in the case of the fraternals The investigator's observations have convinced him that the competition and motivation were as high in one group as in the other—a conclusion which is supported by the parallel nature of the learning curves for the two groups (see data of Table 10) If the identical twins did strive to be similar in their performances, it was not noticeable in their laboratory behavior, indeed, there was evidence to indicate that a large proportion of these boy-pair identicals, contrary to popular opinion, rebel against the idea of being considered very much alike

To explain the findings on the basis of nurture influences, one must assume that the two individuals of an identical pair have been subjected to much *greater similarity of nurture factors than have the* two of a fraternal pair, and that this greater similarity is sufficient to account for the large difference in the resemblance coefficients for fraternals and identicals. It must be further assumed that the supposedly greater similarity of nurture influences for identicals is as potent in motor abilities as in intellectual ability, and that this greater similarity has had the same effect in the case of those skills wherein there has been no chance for specific practice as in the case of those performances in which specific practice may have occurred. The writer's experience with twins in this investigation has led him to believe that the assumption of a much greater similarity of nurture factors for identicals is not tenable, especially with regard to the type of environment which offers opportunity for the development of muscular coordination.

To ascribe the different degrees of resemblance between identical and fraternal twins to a difference in hereditary origin is to accept the explanation most accordant with the facts. The parallel between the resemblance coefficients for anthropometric traits (which are accepted as being due to heredity), for intelligence, and for motor skills, and the parallel between the coefficients for those skills subject to specific training and those which are not, are both consistent with the hereditary and inconsistent with the environmental hypothesis.

Summarized briefly, this research has found that 46 fraternal and 47 identical pairs of male twins of junior-high-school age show the same order of resemblance in the case of five performances requiring skill as in the case of anthropometric measurements, and the writer concludes that the hereditary hypothesis is the most plausible explanation of individual differences in motor skills.

References

1. Cummins, H. Dermatoglyphics in twins of known chorionic history, with reference to diagnosis of twin varieties *Anat Rec*, 1930, **46**, 179-198.
2. Curtius, F. Nachgeburtsbefunde bei Zwillingen und Ähnlichkeitsdiagnose. *Arch. f Gynakol*, 1930, **140**, 361-366.
3. Dahlberg, G Twin births and twins from a hereditary point of view Stockholm: Tidens Trycheri, 1926 Pp 296+15+85.
4. Fisher, R. A. Statistical methods for research workers (2nd ed.) London Oliver & Boyd, 1928 Pp. 269

5 GARFIEL, E The measurement of motor ability *Arch Psychol*, 1923, 9, No. 62. Pp 47

6. HOLZINGER, K J The relative effect of nature and nurture influences on twin differences *J. Educ. Psychol*, 1929, 20, 241-248.

7 KELLEY, T L Statistical method. New York. Macmillan, 1924 Pp. 385

8. KLEIN, P Zur Frage der Diagnose der Eineiigkeit bei Zwillingsschwangerschaft *Arch f Gynakol*, 1927, 130, 788-812

9. KOMAI, T Criteria for distinguishing identical twins. *Quar Rev Biol.*, 1928, 3, 408-418.

10 NEWMAN, H. H Studies of human twins I Methods of diagnosing monozygotic and dizygotic twins. *Biol. Bull*, 1928, 55, 283-297

11 ——— The finger prints of twins *J Genetics*, 1930, 23, 415-447

12. PEARSON, K On the influence of natural selection on variability and correlation of organs. *Phil. Trans Roy Soc London*, 1903, 200, 1-66

13. ——— On the influence of double selection on the variation and correlation of two characters *Biometrika*, 1908, 6, 111-112

14 ———. On the general theory of the influence of selection on correlation and variation *Biometrika*, 1912, 8, 437-443.

15 PERRIN, F A C. An experimental study of motor ability *J Exper Psychol.*, 1921, 4, 24-57

16 SEASHORE, R H Stanford motor skills unit *Psychol. Monog*, 1928, 39, No 2, 51-66

17. ——— Individual differences in motor skills. *J Gen Psychol*, 1930, 3, 38-66

18. SIEMENS, H W The diagnosis of identity in twins *J. Hered*, 1927, 18, 201-209

19 STOCKS, P A biometric investigation of twins and their brothers and sisters *Ann. Eug*, 1930, 4, 49-108

20 VERSCHUER, O v Die Ahnlichkeitsdiagnose der Eineiigkeit von Zwillingen *Anthrop. Anz*, 1928, 5, 244-248.

21. WHIPPLE, G M. Manual of mental and physical tests Baltimore Warwick & York, 1910 Pp 533.

22. WILDER, H H Duplicate twins and double monsters *Amer J. Anat*, 1904, 3, 387-473

23 WILSON, P T, & JONES, H E A study of like-sexed twins I. The vital statistics and familial data of the sample *Human Biol*, 1931, 3, 107-132.

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LES RESSEMBLANCES ENTRE LES JUMEAUX À L'ÉGARD DES HABILETÉS MOTRICES, ET L'EFFET DE L'EXERCICE LÀ-DESSUS

(Résumé)

Cette enquête a essayé de jeter de la lumière sur l'héritage de certains actes où il s'agit des coordinations musculaires au moyen de constater la ressemblance relative des jumeaux fraternels et identiques, et de déterminer l'effet d'une quantité limité d'exercice sur les ressemblances entre les jumeaux Les tests d'habileté motrice employés ont été le test de fermeté de Whipple, le test de vitesse de Miles, le test de rotation de Koerth, le test de Brown consistant à ranger des bobines, et le triage de cartes. Les trois derniers ont été aussi employes comme tâches d'exercice On a obtenu des données pour 98 paires de jumeaux mâles de l'âge de la "junior high school," dont 47 ont été classés comme identiques et 48 comme fraternels, les autres 3 paires étant indéterminées Chaque paire a passé environ cinq heures au laboratoire où on leur a fait subir plusieurs séries d'épreuves sur chacune des cinq tâches, les deux d'une paire travaillant dans exactement les mêmes conditions On a obtenu des mobiles excellents en appuyant sur la concurrence entre les paires et en pressant chacune de battre son record On a évité la fatigue en donnant une période de repos de temps en temps Les principales limitations de cette recherche sont deux: le choix et les erreurs du diagnostic de l'identité On montre le fait que ces facteurs opèrent en sorte de réduire la différence entre les coéfficients de ressemblance entre les deux types de jumeaux

Les résultats indiquent que les jumeaux montrent le même ordre de ressemblance pour les habiletés que pour les traits anthropométriques et qu'une quantité limitée d'exercice a un effet insignifiant sur les ressemblances entre les jumeaux à l'égard de certaines habiletés La considération de la conformité entre les ressemblances à l'égard des habiletés et celles à l'égard des traits anthropométriques et entre les habiletés sujettes au dressage spécial et celles non sujettes a fait conclure à l'auteur que l'origine des différences individuelles à l'égard des habiletés motrices est héréditaire plutôt que due au milieu

McNEMAR

ÄNLICHKEITEN ZWISCHEN ZWILLINGEN IN BEZUG AUF MOTORISCHE GEWANDTHEIT, UND DIE EINWIRKUNG DER EINÜBUNG DARAUF

(Referat)

In dieser Untersuchung ist der Versuch gemacht worden, die Frage der Vererbung gewisser, Muskelkoordinierungen (muscular coordinations) in Anspruch nehmender Tatigkeiten dadurch zu behellen, dass man die relative Anlichkeit geschwisterlicher (fraternal) und identischer Zwillinge erforschte und die Einwirkung einer beschränkten Einubung auf die Anlichkeiten zwischen Zwillingen bestimmte. Die verwendeten Tests der motorischen Gewandheit waren, der Whipple'sche Festigkeitsprufer [Whipple steadiness tester], der Miles'sche Schnelligkeitseinuber [Miles' speed drill], der Koerth'sche Verfolgungsrotor [Koerth pursuit rotor], der Brown'sche Spulenpacker [Brown spool packer], und das Auslesen von

Karten [card sorting] Die drei letzteren wurden auch als Einubungsaufgaben verwendet. Es wurden Befunde gesammelt an 98 mannlichen Zwillingspaaren, im junior-high-school Alter [etwa 11 bis 15 Jahre], von denen 47 als identische und 48 als geschwisterliche Zwillingspaare diagnostiziert worden waren, wahrend 3 Paare unbestimmt blieben Jedes Paar verhielt sich ungefahr funf Stunden lang im Laboratorium. Wahrend dieser Zeit machten sie mehrere Versuchsserien an jeder der 5 Aufgaben durch Die zwei Mitglieder eines Paares arbeiteten immer unter genau den selben Umstanden Eine ausgezeichnete Motivierung wurde dadurch verschafft, dass man die Konkurrenz zwischen den beiden Mitgliedern eines Paares betonte, und jedem aufdrangte, seine eigene Leistung zu verbessern Die Ermudung wurde dadurch vermieden, dass man Ruheperioden einschaltete Diese Untersuchung leidet unter zwei Hauptbeschrankungen—die Auslesung und die Fehler bei der Diagnostizierung der Identitat. Es wird darauf hingewiesen, dass beide Beschrankungen so einwirken, dass sie den Unterschied zwischen den Koeffizienten der Anlichkeit zwischen den zwei Zwillingsarten verminderten

Die Befunde weisen darauf hin, dass Zwillinge in Bezug auf Gewandtheiten den selben Grad der Anlichkeit aufweisen wie in Bezug auf anthropometrische Eigenschaften, und dass Übung, in beschranktem Masse, in ihrer Einwirkung auf die Anlichkeit zwischen Zwillingen in Bezug auf gewisse Gewandtheiten unbedeutend ist Eine Betrachtung der Parallele zwischen den Anlichkeiten in Bezug auf Gewandheiten und auf anthropometrische Eigenschaften, und zwischen Gewandtheiten, die spezifischer Einubung unterworfen sind und solche die es nicht sind, fuhren den Verfasser zu dem Schlusse, dass individuelle Unterschiede in Bezug auf motorische Gewandtheiten eher der Vererbung als der Umgebung entspringen

McNemar

DIFFERENCES IN MUSICAL ABILITY IN CHILDREN OF DIFFERENT NATIONAL AND RACIAL ORIGIN*[1]

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I INTRODUCTION

In reviewing the literature dealing with racial and national differences in musical ability one is impressed with the fact that very little scientific work has been done in this field. The few studies that deal with the subject limit themselves to Negro-white comparisons In 1927 Kwalwasser (12) said, "At the present time, all races are treated more or less alike musically, but hardly impartially. Probably no other field in music is as fertile for research as race testing."

That this lack of data is not due to lack of interest is fairly evident. One has only to listen to a discussion of racial or national differences of any kind to note the striking amount of enthusiasm that accompanies such a discussion. However, this enthusiasm is apt to be caused by emotional patriotism rather than by sound scientific knowledge. Each race produces its Paderewski, its Jenny Lind, its Kreisler, and by these foremost musical figures it symbolizes the achievement of the whole race.

There are probably two important reasons why scientific studies in racial differences in musical ability have been neglected. First, there has been a lack of the proper laboratory instruments, and, secondly, there has been a distrust of such mechanical means of measuring an art.

Carl E. Seashore, the pioneer in the development of laboratory methods for measuring musical ability, started his research as early

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[1]This paper is an abstract of a thesis done at the Institute for Juvenile Research in partial fulfillment for the degree of Master of Arts at the University of Illinois The data have been much abbreviated for the purpose of publication, but complete data may be secured by writing to the author Studies from the Institute for Juvenile Research, Chicago, Series C, No. 205.

as 1901. In 1919 his tests of musical talent were issued in their present form Seashore's book, *The Psychology of Musical Talent*, published at the same time, represents the culmination of many years of scientific study and is still considered the source book and authority for the psychological study of musical talent It describes the basic sensory capacities that make up musical ability and the means for the measurement of these capacities.

At the present time the Seashore tests are nationally known and used, although principally for prognostic and diagnostic purposes, rarely for the measurement of racial differences. Until very recently they were the only well-standardized tests of this nature

In 1930 the Kwalwasser-Dykema music tests appeared which are in some ways an improvement over the Seashore tests. The Victrola records are shorter, more interesting, and better constructed mechanically The question of their reliability, however, has not yet been decided and up to the present time there has been no published work using these tests to measure musical ability.

A valid objection to the use of music tests is that an ability which depends to such a large extent on subjective and emotional factors can hardly be reduced to quantitative measurements However, we must admit that there are certain mechanical components of musical ability which are measurable A good opera singer has to be able to discriminate fine pitch differences, a good pianist must have a feeling for time, and a drummer must be able to distinguish changes in rhythm.

It is these mechanical, objective factors that music tests claim to measure, even though the elusive "passion" of music may escape

The main purpose of this study is to discover any reliable racial and national differences in musical ability as indicated by these tests which we employed. Incidental to the main purpose, an attempt has been made to determine the reliability of each of the tests and the correlation between the Seashore and Kwalwasser-Dykema tests.

II. Previous Studies

A. Racial Differences. So far as the writer has been able to discover, all previous studies on racial differences in musical ability have used only the Seashore tests and have confined themselves to a comparison of Negroes and whites.

In 1924 Lewis and Peterson gave the two Seashore tests of pitch and consonance to approximately 300 whites and 270 Ne-

groes. Both tests were given twice On the first application the Negroes were found to be superior in both tests. However, the difference was reliable only in consonance

On the second application the Negroes gained in pitch but lost slightly in consonance, whereas the whites gained considerably in both pitch and consonance, even to the point of excelling the Negroes in consonance. The racial differences in the second application were both held to be statistically unreliable. It was considered that the large gain on the part of the whites was due to the selection of subjects.

Peterson and Lanier (6) in 1929 gave all six Seashore tests to about 380 whites and 290 Negroes. The results showed a statistically reliable superiority of whites in all of the Seashore tests except rhythm

Miss Streep (7), after giving the Seashore tests of rhythm and consonance to 637 white and 678 Negro children, found a slight Negro superiority in both rhythm and consonance.

Gray and Bingham (3) made a comparison of the music scores of Negroes and whites of the seventh and eighth grades and found that the whites were superior to the Negroes on all of the Seashore tests except consonance, in which the races were nearly equal.

Johnson (4) gave the Seashore tests to 3300 fifth- and eighth-grade pupils and college students. Comparing their scores with the Seashore norms for whites, he found no significant differences between Negro and white scores.

Garth and Ishill (2) tested 409 mixed-blood and 360 full-blood Indian children, using the Seashore records, and compared them with the norms for white children. It was found that the Indians showed a slightly higher rating in time and rhythm, an inferiority in consonance, and a marked deficiency in pitch, intensity, and memory.

Farnsworth (1) tested 36 American-born Japanese and Chinese students at the Universities of California and Stanford and contrasted the results with those of 53 students of "similar nationalities and scholastic status" who had lived in America for a shorter time. He also made comparisons with white students He claimed that his white subjects were superior in all of the tests except Kwalwasser's melodic sensitivity test. From an examination of his data, especially of the indices of significant differences, it is doubtful,

excepting for the case of harmony, whether he secured any real differences between comparably trained whites and Chinese.

B. Reliability of the Tests Used No reliability coefficients for the Kwalwasser-Dykema tests have been worked out previous to this study.

Table 1 lists reliability coefficients obtained by various authors for the three Seashore tests. pitch, intensity, and memory.

TABLE 1
RETEST RELIABILITIES OF SEASHORE TESTS

Author	Number of cases	Reliability of Seashore Pitch	Reliability of Seashore Intensity	Reliability of Seashore Memory
McCarthy (15) (several retests)	58	67 to 71	48 to 69	85 to 94
Highsmith (10)	59	.76	50	82
Larson, R C (13)	35	83	.80	87
Brown, A W (8)	92	71	.65	59
Ruch, G M, & Stoddard, G B. (16)	100	.70	66	.66
Peterson & Lanier (6)	380 (white)	69	.75	67
	290 (Negroes)	58	85	80

III PRESENT STUDY

A. Materials Three of the Seashore test records for musical talent were used: pitch, intensity, and memory These were selected because most reports indicate that they have the highest reliability of the tests in the Seashore battery These tests are on double-disk Columbia records numbered 53004-D, 53003-D, and 53000-D respectively

The ten records which constitute the Kwalwasser-Dykema tests for musical ability were also employed in this investigation They include the following tests. tonal memory, quality, intensity, time, rhythm, tonal movement, pitch discrimination, taste, pitch imagery, and rhythm imagery. These five double-faced phonograph records are of the Victor series, numbers 302, 303, 304, 305, and 306.

In addition, each child was asked to fill out a questionnaire, a copy of which follows:

QUESTIONNAIRE

Name (Last (First) (Middle) Date

School Grade Birthday

Nationality Birthplace (State & Country)

Of mother

Of father

Of mother's mother

Of mother's father

Of father's mother

Of father's father

1 Name the musical instruments in your home

2 Who plays these instruments?

3 Have you ever taken piano lessons? hours per week for years.

4 Have you ever taken lessons on any other instrument?

Kind hours per week for years.

5 Have you played a musical instrument in public?

Alone or with group . What instrument?

How often Where

6. Are any members of your family engaged in musical professions? Answer specifically.

These data were used as a check on the child's age and nationality. The remainder of the information indicated on the questionnaire will be used in subsequent research on the validity of the battery of tests employed as well as for a measurement of the effect of special training on the subject's performance

B Subjects The examiner selected children from the following racial and national groups: Negro, Jewish, German, Italian, and Polish. An attempt was made in the case of the Polish, Italian, and German to use only those children whose parents and all of whose grandparents were born in Poland, Italy, and Germany, respectively. In a very few cases subjects were used whose one parent was born in the United States, the other parent and all grandparents being born in the foreign country which the subject represented.

In selecting Jewish subjects, care was taken to choose only those

children whose parents were both of Jewish extraction. For the greater part these parents were Russian Jews

In the case of the Negro subjects an attempt was made to select only those whose parents were of pure Negro strain. However, it is questionable whether this attempt was entirely successful.

All of the subjects except the Jewish were taken from the eighth grades of the Chicago Public Schools. The Negro children were tested in two schools, the Polish in three, the Italian in three, and the German in four. The Jewish children were taken from a Jewish orphanage in Chicago, and subjects from the seventh to the tenth grade were used In a recent survey of the school, this group of children was found to be of average intelligence. They attend public schools in the city during the day and enjoy as many recreational, social, and cultural advantages as do children living with their own parents.

It may be said here that it is doubtful whether each of these groups represents the same level of cultural advancement. Although the examiner partially controlled this factor, first, by choosing children from the public schools and, secondly, by selecting children of immigrant parentage, it is probable that children of Jewish and German extraction represent a higher degree of cultural development than do those of the other three groups. However, it is questionable just how far cultural advantages, which in this case would mean a greater amount of musical instruction, influences the results of the music tests which we use

Stanton and Koerth (21) found that students retested after three years of musical training showed but slight gains on the six Seashore tests. They did not feel justified in explaining these gains as due to the effects of musical education but ascribed them to "cognitive factors as well as other attendant circumstances"

Table 2 gives the average age and number of children in each group

TABLE 2
AVERAGE AGE AND NUMBER OF EACH GROUP

Group	Number	Average chronological age
Polish	125	14-8
Negro	102	14-11
Italian	138	14-6
German	72	14-1
Jewish	113	14-1

C Method. The tests were usually administered in two sittings except when necessity demanded that the entire battery be given at one time. The latter procedure occurred twice, once while testing a group of some fifty Negro subjects and again while testing the Jewish group.

The examiner carefully followed the directions for administration as found in the manuals. All of the tests were given by the writer.

At the first sitting the children were asked to fill out the questionnaire The subjects were given careful verbal instructions before each question. Ample time to ask questions of the examiner was allowed

The three Seashore tests were then administered The purpose of the test was explained and the children were told that the results would not be counted either for or against them in their school work

The children were given a practice period consisting of the first ten items in each test and were permitted to call their answers aloud. After the practice an opportunity was given them to ask questions and, if there was any indication of misunderstanding of directions, these ten items were repeated until it was evident that the children understood clearly what they were to do. The subjects were told not to write the answers to these practice exercises They were not permitted to ask questions while the record was playing. During the examination the room was kept as quiet as is possible in a school situation.

At the second sitting the Kwalwasser-Dykema tests were administered The subjects were given the general directions from the K-D manual and specific directions before each test As before, they were given a practice period Because of the shortness of the tests, only the first four items were given as practice

A ten-minute rest period was given after the fifth test of the examination. *During this period the children either rested or* played games

The test groups averaged 45 individuals. The majority of the tests were given in the regular classrooms and during the morning hours before the children were fatigued.

The same procedure was used in testing the groups from which reliability coefficients were obtained. In this procedure the entire test was repeated to the two selected groups approximately one month after the first examination The conditions during the two examinations were kept as constant as possible

IV. Treatment of Data

In order to compare the average performance of each group on the Seashore and K-D tests, the means for the groups with the probable error for each mean were calculated. Such data are included in Tables 3-16

Formula $\frac{M_1-M_2}{PEm_1-m_2}$ was used to ascertain which differences between the means of the five groups were true and significant ones and which were chance differences. For example, when the difference between the means divided by the probable error of that difference is 3 0, there are 97 9 chances in 100 that the true difference (the difference between the true means) is greater than zero. Accordingly, we have considered 3.0 as the minimum index of significant difference.

In the following tables those differences which we consider significant are shown in bold-face type.

V Results

A Racial and National Differences. In each of the following tables the groups have been so arranged in the vertical columns that the group having the highest mean heads the columns, while that having the lowest is last

When noting the figure expressing the ratio $\frac{M_1-M_2}{PEm_1-m_2}$ it is well to bear in mind that this figure always represents the superiority of the race in the vertical column over that in the horizontal

TABLE 3
MEANS AND RELIABILITY OF THE DIFFERENCES BETWEEN MEANS FOR EACH GROUP ON THE SEASHORE PITCH TEST

Group	Means	German	Significant ratios Italian	Negro	Polish
Jewish	67 7± 78	1 1	**4 6**	**6 7**	**7.4**
German	8 62±1 02		2 7	**4 5**	**5.0**
Italian	63 0± 66			2 4	**3.1**
Negro	60 7± 69				0 6
Polish	60.1± 68				

It is seen that the Jewish group is significantly superior to the Italians, Negroes, and Poles. The Germans show significant superi-

ority to the Negroes and Poles, while the Italians are superior to Poles.

TABLE 4

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE SEASHORE INTENSITY TEST

Group	Means	Significant ratios			
		Italian	Negro	German	Polish
Jewish	76 4± 63	1 6	1 8	3 1	3 9
Italian	74 9± 69		0 1	1 6	2 2
Negro	74 8± 64			1 5	2 2
German	73 2±.81				0.5
Polish	72.6± 73				

The only significant differences noted are between Jewish and German and Jewish and Polish groups These differences give the superiority to the former in both comparisons

TABLE 5

MEANS AND RELIABILITY OF THE DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE SEASHORE MEMORY TEST

Group	Means	Significant ratios			
		Negro	German	Italian	Polish
Jewish	31 2± 43	4.6	5.7	9 6	14.6
Negro	27 4± 69		0 6	2 7	6.3
German	26 8±.63			2 1	5 9
Italian	25 2± 46				4.6
Polish	22 3± 43				

It is noted that in this test the Jewish group showed a significant superiority to all other groups. The Negroes, Germans, and Italians are likewise superior to the Poles.

TABLE 6

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST OF TONAL MEMORY

Group	Means	Significant ratios			
		Negro	German	Italian	Polish
Jewish	17 0± 17	0 3	3.3	6.7	8 1
Negro	16 9± 21		2.7	4.8	6.9
German	15 2± 19			1 9	4 2
Italian	15 7±.15				2 5
Polish	15 2± 16				

In this test the Jewish group did significantly better than all of the other groups excepting the Negro The Negroes showed a significant superiority to both Italian and Polish groups, while the Germans excelled the Poles

TABLE 7

Means and Reliability of the Difference between Means for Each Group on the K-D Quality Discrimination Test

Group	Means	Significant ratios Jewish	Negro	Italian	Polish
German	22.8± 19	2 8	3 6	4.6	5.2
Jewish	22 1± 15		1 0	2 0	2 7
Negro	21 9± 18			0 8	1 5
Italian	21 7± 14				0 7
Polish	21 6± 14				

In this test the Germans were significantly superior to the Negro, Italian, and Polish Groups

TABLE 8

Means and Reliability of the Difference between Means for Each Group on the K-D Test for Intensity Discrimination

Group	Means	Significant ratios Polish	Jewish	German	Negro
Italian	23.0± 13	0 6	0 9	1 3	5 0
Polish	22 8± 15		0 2	0 7	4 2
Jewish	22 8± 12			0 5	4 3
German	22 7± 15				3 4
Negro	22.0± 15				

All groups are significantly superior to the Negro.

TABLE 9

Means and Reliability of Difference between Means for Each Group on the K-D Tonal Movement Test

Group	Means	Significant ratios Jewish	Negro	Polish	Italian
German	15 7± 33	0 7	1 8	2 3	3.4
Jewish	15.4± 29		1 1	1 6	2 8
Negro	15 0± 25			0 5	1 8
Polish	14 8± 22				1 4
Italian	14 4± 22				

The only significant difference is that of the German over the Italian group

TABLE 10

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST OF TIME DISCRIMINATION

Group	Means	Significant ratios Negro	Italian	Jewish	Polish
German	18 8± 21	0 8	1 8	2 1	4 5
Negro	18 5±.17		1 1	1 5	4.2
Italian	18 3± 16			0 5	3 3
Jewish	18 2± 18				2 6
Polish	17 5± 18				

In this the German, Negro, and Italian groups show a significant superiority over the Polish.

TABLE 11

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST FOR RHYTHM DISCRIMINATION

Group	Means	Significant ratios Jewish	Italian	German	Polish
Negro	18 4± 17	2 1	4 0	4.4	8.2
Jewish	17.9± 14		2 0	2 7	6.7
Italian	17.5± 13			1 1	6.0
German	17 3± 19				3 2
Polish	16 5± 15				

In this the Negroes show a marked superiority to all the other groups excepting the Jewish. All of the groups show a valid superiority over the Polish.

TABLE 12

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST FOR PITCH DISCRIMINATION

Group	Means	Significant ratios German	Italian	Negro	Polish
Jewish	25 9± 25	1.8	2 3	2 5	7.7
German	25 2± 29		0 4	0.6	5.1
Italian	25 1± 25			0 2	5.2
Negro	25 0± 27				4 7
Polish	23.3± 22				

It is seen that all of the other groups are significantly superior to the Polish on this test.

TABLE 13

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST OF MELODIC TASTE

Group	Means	Significant ratios Polish	German	Jewish	Italian
Negro	12.9± 15	0 6	0 8	1 6	2 8
Polish	12 8± 14		0 3	1 0	2 3
German	12 7± 21			0 6	1 5
Jewish	12 5±.18				1 0
Italian	12 3± 15				

It is interesting to note that no significant differences were indicated.

TABLE 14

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TEST OF PITCH IMAGERY

Group	Means	Significant ratios German	Italian	Polish	Negro
Jewish	15 2± 16	1 5	3 2	5.4	5.6
German	14 9± 16		1 4	3.9	4 0
Italian	14 6± 11			3.0	3.1
Polish	14 1±.14				0 0
Negro	14 1± 13				

The Jewish subjects were significantly superior to the Italian, Polish, and Negro The Germans and Italians each showed significant superiority over the Poles and Negroes.

TABLE 15

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D RHYTHM IMAGERY TEST

Group	Means	Significant ratios German	Italian	Negro	Polish
Jewish	18 0± 18	4.3	8.1	8.9	10 9
German	16 7± 24		2 6	3.6	5 0
Italian	15 9± 18			1 2	2.7
Negro	15 6± 19				1 4
Polish	15 2± 18				

The Jewish show significant superiority to all other groups, while the Germans excel the Negroes and Poles.

TABLE 16

MEANS AND RELIABILITY OF DIFFERENCE BETWEEN MEANS FOR EACH GROUP ON THE K-D TOTAL SCORES

Group	Means	Significant ratios German	Negro	Italian	Polish
Jewish	185 5± 96	1 7	4 0	6.9	10 2
German	183 2± 91		2.2	4 2	8.6
Negro	180 6± 78			2.1	6.8
Italian	178 4± 73				4 8
Polish	173 7±.65				

Table 16 shows the racial differences for the average total scores on the K-D test. The Jewish group shows a significant superiority over the Negroes, Italians, and Poles.

The Germans are significantly superior to the Italians and Poles. The Negroes and Italians are each superior to the Poles.

In summarizing the data found in Tables 3 to 16, the following observations can be made

The Polish group tends to have the lowest mean in tests for musical ability. Exceptions to this are found in the K-D Tests of Melodic Taste (Table 13) and Intensity Discrimination (Table 8), in which they rank second; and in the K-D Tests of Tonal Movement (Table 9) and Pitch Imagery (Table 14), in which they rank fourth. However, in the Melodic Taste Test the differences between the Polish group and the other four groups are not significant In the Intensity Discrimination Test they are significantly superior only to the Negroes which are the lowest group In the Tonal Movement and Pitch Imagery Tests the difference between the mean for the Polish group and the mean of the lowest group is not a significant one.

Thus we find that the only significant Polish superiority found is their precedence over the Negroes in the Intensity Discrimination Test

On the other hand, the Jewish group excels all other groups in the majority of tests Exceptions to this are found in the Melodic Test (Table 13), in which they rank fourth, in the Time Discrimination Test (Table 10), in which they rank fourth, in the Tonal Movement Test (Table 9), in which they rank second, in the Quality Discrimination Test (Table 7), in which they rank second; in the Rhythm Discrimination Test (Table 11), in which they rank

second; and in the K-D Intensity Discrimination Test (Table 8), in which they rank third.

It is interesting to note, however, that in no case are there any significant differences between the superior group and the Jewish.

The Germans are only very slightly inferior to the Jews in musical ability In three tests, K-D Time Discrimination (Table 10), Tonal Movement (Table 9), and Quality Discrimination (Table 7), they surpass the Jewish group, although not significantly In five tests they are second to the Jewish group, but in only one of these, Rhythm Imagery (Table 15), is that difference a true one. In three tests, K-D Tonal Memory (Table 6), Seashore Memory (Table 5), and K-D Rhythm Imagery (Table 15) the Jews show a significant superiority to the Germans, and in one test, Rhythm Discrimination (Table 11), the Negroes are validly superior

The Italians show a general tendency to be third in the group of five. In six tests they hold third place, in four tests they hold fourth place, in two tests they hold fifth place, in one test they hold second, and in one test, K-D Intensity Discrimination (Table 8), they hold first place

They are significantly superior to the Poles in seven tests and superior to the Negroes in two tests, K-D Intensity Discrimination (Table 8) and Pitch Imagery (Table 14)

It is interesting to note that there is only one test in which the Negroes show a definite superiority over all other groups. On this test, Rhythm Discrimination (Table 11), they are validly superior to all other groups except the Jewish Although the Negroes have the highest mean in the Melodic Taste Test (Table 13) it is improbable that the differences between Negroes and other races is a true one.

In K-D Tonal Memory (Table 6) the Negroes are second to the Jews and are significantly superior to the Italians and Poles In Time Discrimination (Table 10) this race is second to the German and shows a true superiority over the Polish In K-D Pitch Discrimination (Table 12) and in the K-D Total Scores (Table 16) the Negroes are significantly superior to the Poles

In comparing the rankings made by the races on the Seashore Pitch Test (Table 3), with the rankings on K-D Pitch Test (Table 12), one finds close agreement in both rank and size of difference The same holds true in comparing Seashore Memory (Table 5) with K-D Memory (Table 6). However, one finds no

agreement whatever between Seashore Intensity (Table 4) and K-D Intensity (Table 8) This is probably due to the low correlation between the two tests.

In the results of the intercorrelations found in Table 17 one finds that the correlation between Seashore Intensity and K-D Intensity is very low. The two tests are probably testing somewhat different aspects of the same capacity, so one could hardly expect to find similar racial rankings in both

The two K-D tests of Pitch Imagery and Rhythm Imagery are both dependent to a large extent on training They both are directly related to the ability of the subject to read music. Subjects having had such training would be likely to have higher scores on these tests. So in comparing the Rhythm Discrimination Test with the Rhythm Imagery Test one finds that the Negroes, who excel in the former, fall to the fourth place in the latter This would lead us to conclude that, whereas the Negroes have excellent sensory capacity in rhythm discrimination, their formal training in rhythm imagery is deficient.

On the other hand, one finds a fairly close correspondence in rankings in the Pitch Discrimination and Pitch Imagery Tests. This probably indicates that capacity and training have been more evenly balanced.

In considering the number of significant differences found in each test one sees that the Melodic Taste Test fails to show any significant racial differences. The writer questions the value of this test as a measurement of a musical ability "Taste" in any field of art is a subjective quality, highly dependent on many extraneous factors In addition, this test contains only ten different items which are repeated twice. One can hardly expect a test as short as this to be valid or to show significant differences

The same criticism can be made of the Tonal Movement Test (Table 9), in which there was only one significant difference. The ability to decide whether the last note in a series should go up or down in order to complete a harmonious sequence of notes is rather questionable as a pure element of musical ability.

There are 140 measurements of differences in these 14 tests of musical ability. Of this number, 62 are considered statistically significant according to the criterion which we have arbitrarily chosen as large enough for our purposes.

B Correlation between Seashore and K-D Tests In computing

TABLE 17

CORRELATION BETWEEN SEASHORE AND K-D TESTS

Tests	Number	Correlation
Seashore Pitch and K-D Pitch	664	.43 ± .02
Seashore Intensity and K-D Intensity	676	.27 ± .02
Seashore Memory and K-D Memory	672	.48 ± .02

the correlations between the three Seashore tests of pitch, intensity, and memory and the corresponding K-D tests, we used all of the cases on which this study was based. The Pearson product-moment formula was employed for all correlations.

Table 17 shows the number of cases and the correlation coefficients obtained in the comparisons.

The above correlations are fairly low. This may be due to the fact that, although the tests are submitted by the authors for measuring identical capacities, in reality they measure musical components having but a small degree of similarity.

In view of the low reliability coefficients which we obtained (see Table 18), we could hardly expect the correlations between the Seashore and K-D tests to be very much higher. Kelley (11) has pointed out that the maximum correlation which can be obtained between any two traits cannot, except by chance, exceed the square root of the product of their respective correlation coefficients ($r_{a_1a_2} \times r_{b_1b_2}$).

C. Reliability. Table 18 gives reliability coefficients obtained by retesting two different groups. About one month elapsed between the administration of the first and second tests. The method used has already been described in Part III, *C*.

The reliability coefficients of the three Seashore tests for both Polish and Jewish groups are far lower than those obtained by other workers (Table 1). Up *to the present writing no reliabilities* on the K-D tests have been published other than our own.

It can be seen (Table 18) that the majority of our reliability coefficients are low and likewise vary considerably between racial groups.

TABLE 18

RELIABILITY COEFFICIENTS

Test	Polish group Number	Polish group Rel. coeff.	Jewish group Number	Jewish group Rel. coeff.
Seashore Pitch	71	.72± 04	74	.55±.05
Seashore Intensity	69	27± 08	74	32± 07
Seashore Memory	67	.38±.07	74	64± 05
K-D Tonal Memory	76	.34± 07	73	51± 06
K-D Quality	76	20± 07	73	08± 08
K-D Intensity	71	.07± 08	73	12± 08
K-D Tonal Movement	72	57± 05	72	39± 07
K-D Time	72	19± 08	72	11± 08
K-D Rhythm	73	.27± 07	72	.04± 08
K-D Pitch	73	.34± 07	72	38± 07
K-D Melodic Taste	73	10±.08	72	06± 08
K-D Pitch Imagery	72	.14±.08	72	28±.07
K-D Rhythm Imagery	72	31± 07	72	.37± 07
K-D Total Scores	69	61±.05	71	48± 06

A possible factor contributing to our low reliability coefficients lies in the fact that both groups used in obtaining these coefficients of reliability are definitely homogeneous in respect to age, grade, and race. The majority of the children tested were in the eighth grade and consequently of approximately the same chronological age

To quote Kelley (11) on the question of the effect of obtaining reliability coefficients for a single grade "To secure a reliability coefficient of 40 from a group composed of children in a single grade is probably indicative of greater, not less reliability than to secure a reliability coefficient of 90 from a group composed of children from second to twelfth grades. The spread of talent is four times as great in eleven grades as in a single grade. The correlation in the second case would have to be .914 in order to indicate as close a relationship as that shown by a reliability coefficient of 40 in a single grade."

We feel that if we had used a less select group in securing our reliability coefficients the *r*'s might have been appreciably higher Therefore, we do not feel that our coefficients of reliability should be regarded as undeniable proof of the low reliability of the tests employed

However, in spite of our low reliability coefficients, we have found distinct racial differences in musical ability. This may be due to the fact that our measurements of reliability gave too low results

because of the homogeneity of our groups, or it may be that such low reliabilities are able to support the fairly large indices of difference which we obtained. With high reliability coefficients it is probable that we would obtain even more discriminating differences.

VI. Conclusions

1. Differences which we consider significant have been found to exist between various racial and nativity groups in the components of musical ability as measured by the Seashore and Kwalwasser-Dykema music tests.

2 According to our results:

a The Jewish group shows a marked superiority to all other groups except the German, which ranks a close second.

b. The Polish group tends to be markedly inferior in tests of musical ability.

c The Negro group shows a definite inferiority to all other racial groups except in performance on the test of rhythm discrimination

d. The Italian group tends to hold a median position in the five racial groups.

3 Low intercorrelations were obtained between the Seashore and K-D tests of pitch, intensity, and memory

4 The majority of the reliability coefficients were found to be low

References

Racial Differences in Music

1 Farnsworth, P An historical, critical, and experimental study of the Seashore-Kwalwasser Test Battery *Genet Psychol Monog*, 1931, 9, 291-393

2 Garth, T R, & Isbell, S R The musical talent of Indians *Music Supervisor's J.*, 1929, 15, 83, 85-87

3 Gray, C T, & Bingham, C W A comparison of certain phases of musical ability of colored and white public school pupils *J Educ Psychol.*, 1929, 20, 501-506

4 Johnson, C B A summary of negro scores on the Seashore musical talent tests *J Comp Psychol*, 1931, 11, 383-393

5 Nathanson, Y S The musical ability of the negro *Ann. Amer Acad Polit & Soc. Sci*, 1928, 140, 186-190

6 Peterson, J, & Lanier, L H Studies in the comparative abilities of whites and negroes *Ment Meas Monog*, 1929, No 5. Pp iv+156.

7 Streep, R L A comparison of white and negro children in rhythm and consonance *J Appl Psychol*, 1931, 15, 53-71

General

8 BROWN, A W The reliability and validity of the Seashore tests of musical talent *J. Appl Psychol*, 1928, 12, 468-476.

9 FRACKER, G. C., & HOWARD, V. M. Correlation between intelligence and musical talent among university students *Psychol. Monog*, 1928, 39, No 178, 157-161.

10 HIGHSMITH, J A. Selecting musical talent *J. Appl Psychol.*, 1929, 13, 486-493

11 KELLEY, T. L The reliability of test scores *J Educ. Res.*, 1921, 3, 370-379

12 KWALWASSER, J. Tests and measurements in music Boston Birchard, 1927 Pp. 159

13 LARSON, R. C Studies on Seashore's measures of musical talent. *Univ Iowa Stud., Ser Aims & Prog. Res.*, 1930, 2, No 6 (First ser, No 174). Pp 83

14. LARSON, W S Measurement of musical talent for the prediction of success in instrumental music *Psychol. Monog.*, 1930, 40, No. 181, 33-73.

15 MCCARTHY, D A study of the Seashore measures of musical talent *J. Appl Psychol.*, 1930, 14, 437-455

16 RUCH, G. M, & STODDARD, G D Tests and measurements in high school instruction Yonkers, N Y World Book Co., 1927. Pp. xvi+373

17. SEASHORE, C. E Present status of research in the psychology of music at the University of Iowa *Univ Iowa Stud Ser Aims & Prog Res.*, 1928, 2, No 157. Pp. 29.

18 ———— The psychology of musical talent Boston Silver Burdette, 1919 Pp xvi+288

19. ———— Psychology in music; the role of experimental psychology in the science and art of music. *Musical Quar.*, 1930, 16, 237

20 STANTON, H M Psychological tests of musical talent. Rochester, N Y Univ Rochester, Eastman School of Music, 1925 Pp 48

21. STANTON, H. M, & KOERTH, W. Musical capacity measures of adults repeated after music education. *Univ Iowa Stud. Ser Aims & Prog. Res.*, 1930, No 31 (First ser, No 189) Pp. 18.

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LES DIFFÉRENCES DE TALENT MUSICAL CHEZ LES ENFANTS DE DIVERSES ORIGINES NATIONALES ET DE DIVERSES RACES

(Résumé)

Au moyen des trois Tests de Seashore de hauteur, d'intensité et de mémoire et de toute la série des tests de Kwalwasser-Dykema, l'auteur a testé approximativement 100 enfants de parents polonais, nègres, italiens, allemands et juifs dans le but de découvrir s'il y avait des différences nationales ou de race dans le talent musical comme mesuré par ces tests.

On a choisi les enfants parmi les élèves de huitième année des écoles élémentaires de Chicago

On a maintenu les conditions des tests aussi uniformes que possible On a essaye d'avoir des enfants d'approximativement le même âge et le même niveau cultural

Pour comparer le rendement de chaque groupe, on a calculé les erreurs moyenne et probable pour chaque test Ensuite la différence des moyennes divisée par l'erreur probable de cette différence a été employée comme formule pour déterminer si ces différences ont été réelles et significantes On a choisi 3,0 comme indice minimum d'une différence significante.

On a obtenu les résultats suivants: (1) le groupe juifs a montré une superiorité marquee sur tous les autres groupes sauf l'allemand, qui a été à peu près égal; (2) le groupe polonais a semblé inférieur d'une façon marquée, (3) le groupe nègre a montré une infériorité bien marquée à l'égard de tous les autres groupes sauf dans le test de discrimination des rythmes, (4) le groupe italien a tendu à maintenir une position moyenne parmi les cinq groupes, (5) on a obtenu des intercorrélations peu élevées entre le test K-D et le Seashore, (6) la plupart des coéfficients de constance se sont montrés peu élevés SANDERSON

UNTERSCHIEDE IN BEZUG AUF MUSIKALISCHE BEGABUNG BEI KINDERN VERSCHIEDENER LANDES- UND RASSENABSTAMMUNG

(Referat)

Mit den drei Seashore Tests—Tonhohenunterscheidung, Intensitatenunterschiedung, und Gedachtnis fur Musik (pitch, intensity, and memory)—und der gesamten Kwalwasser-Dykema Testgruppe prufte der Verfasser ungefahr 100 Kinder Polnischer, schwarzer, Italienischer, Deutscher, und Judischer Eltern um zu erforschen, ob es in Bezug auf die mit diesen Prufungen gemessene musikalische Fahigkeit Rassen- oder Landesunterschiede gabe

Die Kinder waren Mitglieder der achten Schulklasse der offentlichen Schulen von Chicago

Die Bedingungen der Prufung wurden so einheitlich wie moglich erhalten Es wurde der Versuch gemacht, Kinder in annahernd gleichem Alter und aus annahernd gleichem kulturellen Niveau zu erhalten

Um die Leistungen der verschiedenen Gruppen vergleichbar zu machen wurde an jedem Test die Durchschnittszahl und der wahrscheinliche Fehler berechnet Dann verwendete mann den Unterschied zwischen den Durchschnittszahlen, dividiert durch den wahrscheinlichen Fehler dieses Unterschiedes, als eine Formel zur Bestimmung ob diese Unterschiede echt und bedeutend seien Als minimaler Index eines bedeutenden Unterschiedes wahlte man die Zahl 3 0

Es wurden folgende Befunde erhalten (1) Die Jüdischen Gruppen erwiesen sich als den anderen Gruppen weit uberlegen ausnahme der Deutschen, die in zweiter Stellung, aber den Judischen Gruppen sehr nahe, standen, (2) die Polnische Gruppe schien deutlich tiefer zu stehen, (3) die Negergruppe schien bestimmt tiefer zu stehen, als alle ander Gruppen—nur in dem Test der Rhythmusunterscheidungsfahigkeit nicht; (4) die Italienische Gruppe nahm im grossen Ganzen eine mittlere Stellung unter den funf Gruppen ein, (5) die erhaltenen Korrelationszahlen der K-D und Seashore Tests unter einander waren niedrig (6) Die Mehrzahl der Zuverlassigkeitskoeffizienten erwiesen sich als niedrig SANDERSON

BEHAVIOR CONSTANCY IN RATS*

From the Psychological Laboratories of the University of California

James A Hamilton and Willis D Ellis

I. Introduction

The purpose of this experiment was to study conditions under which *an established behavior pattern persists despite modifications* of the situation for which such behavior was appropriate Situation I, let us say, is satisfied by Behavior I, but the experimenter then introduces factors designed to establish Situation II and eliminate the original situation Whether or not Situation II elicits Behavior II from the subject will depend upon a variety of circumstances The only way in which we can know that Situation I *has* been eliminated when changes amongst its physical aspects are made, is to observe the organism's behavior. If Behavior I persists we may suppose that, despite objective alterations, no significant change in Situation I has occurred A condition of that sort supplies us with information about the nature of Situation I relative to the behaving organism. If Behavior II is observed after objective changes in the situation have been imposed, then we may presume (the proper experimental care having been taken) that such changes caused Behavior I to disappear and permitted or required another behavior.

To investigate these matters we have employed a removal of reward technique, together with a change in the organism itself effected by operation upon the brain As will be discussed more fully hereafter, we believe that a persistence of Behavior I, despite changes in the situation (e g, removal of reward), may under conditions here elaborated be best designated by the term *behavior constancy.*

II Apparatus and Procedure

1 Every effort was made to produce the simplest conditions possible As indicated by the ground plan in Figure 1, the apparatus consisted of an entrance box (A), a 15-cm. alley (Y), a food box

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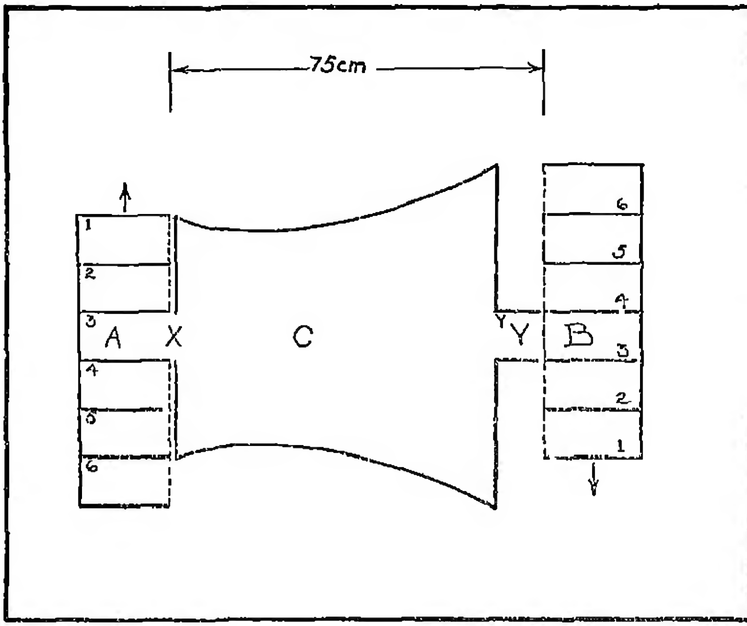

FIGURE 1
DIAGRAM OF THE APPARATUS

(B), and a walled area (C) between The height of the walls was 20 cm The C-area was designed to afford a region without behavior restrictions No artificial distractions were provided and at no time were the animals fed elsewhere than in B. Odors were not removed A swinging door at the far end of Y prevented the animal from seeing inside B until he had pushed through this door Starting- and feeding-boxes were movable as indicated by the arrows A sliding door (X) completed the apparatus.

2. Procedure was kept on a level of utmost simplicity Rats were brought by hand from their home cage nearby and placed in sections of the starting-box. Food (two sunflower seeds) having been placed in each food compartment, the starting-box was moved so that the first section was opposite X and the sliding door lifted The animal emerged into the central area and either proceeded to nose about or went directly to the Y-alley and so to food in B Starting- and food-

boxes were then shifted to permit the next rat to leave *A*. Time elapsed between opening the door at *X* and arrival of the rat in *B* was measured with a stop-watch. Twenty seconds were allowed for eating, after which the animal was returned to his section of the starting-box to await the next opportunity to run.

Variations of several kinds in the type of general conditions were made. Preliminary runs in a darkened room with a small flashlight bulb (*y*) illuminating the opening into *Y* (from outside the central walled area) were later followed by runs in daylight. When animals were accustomed to both procedures these were alternated at irregular intervals. Runs were made mornings and evenings. All animals were fed their daily rations in the food box (*B*) as reward for the last run of the evening series.

3. After the animals were thoroughly familiar with the several conditions,[1] *critical experiments* were introduced. These consisted in following each step of the above procedure except that no food was present in *B* and the animal was returned to *A* immediately after passing into *B*. The critical experiments were carried out under daylight conditions to permit detailed observation of the rats' behavior. For the following two days conditions were made the same as before the critical experiments, the rats finding food at *B*. Critical tests were again given, no evidence of practice effect being apparent. Since behavior in all respects resembled that of the first series, no detailed report of the second is given.[2] In all cases the rats were allowed to run five times from *A* to *B* immediately before the critical experiments. Thus the first run of the tests was really—so far as the animal's behavior showed—a *sixth* normal or regular run.

4. The animals having been submitted, as normal animals, to critical experiments, they were then operated upon and areas of the cortex destroyed by the thermocauteric method. The purpose of this procedure was to establish a changed condition in the animal itself and not to investigate the influence of various amounts or location of cortex destruction. Had the animals been changed in any other manner so that they were no longer normal, this would have satisfied the requirements equally well. In speaking of "normal" and "operated" animals hereafter we shall refer, therefore, to the same rats as regards their condition *before* and *after* operation. Cortex destruc-

[1]For criterion of "thoroughly familiar" see Section III, "Experiments."
[2]For details of the first series see Section IV.

tion proved a satisfactory device for establishing a continued non-normal condition, while at the same time leaving the animals fully able to perform their run from starting-box to food.

Fourteen days after operation relearning was commenced. Critical experiments again consisted in removing food from the reward box and were performed in daylight

III. Experiments

The problem studied did not have to do with the *formation* of an *A*-to-*B* habit but rather with an inquiry into what would follow should conditions congruent with a given behavior pattern be interrupted Each rat was permitted to run as he chose and for as long as was necessary during each trial After 40 runs each normal animal was moving promptly and directly from *A* to *B*, i e, ignoring the middle area. Ten times this number of runs (in all 440) were then given to assure "familiar" behavior relative to this environment before

TABLE 1
Running Speeds Preceding Critical Experiments

No. of rat	Condition	Average speed from A to B during 25 runs preceding removal of reward (in secs)	Average deviation	Difference between average deviations
1	normal	4 2	1 52	0.25
	operated	1 97	0 27	
2	normal	2.5	0 70	0 32
	operated	1 8	0 38	
3	normal	6 5	2 70	5 00*
	operated	10 4	7 70	
4	normal	4 4	1 70	0 59
	operated	3 8	1 11	
5	normal	2 1	0 48	0 05
	operated	2 1	0 43	
6	normal	5 3	1.87	0 09
	operated	2 8	0 78	

*Rat No 3 exhibited a unique type of behavior both when normal and after operation In the column of average deviations his is the only case in which the post-operative was more erratic than normal behavior Comparison of his runs with those of other animals (especially in the "operated" column, see No 4) indicates a characteristic delay in leaving the starting-box

critical experiments were introduced. The same rats, after operation, ran directly from *A* to *B* in 13 trials Ten times this number of runs (in all 143) were then given before *critical experiments* were introduced.

It is apparent from the fact that whereas 40 trials were required by normal animals before prompt and unbroken *A*-to-*B* behavior resulted, only 13 were necessary for the same animals after operation.

The average speeds for each animal in both normal and operated condition for the last 25 runs immediately preceding removal of reward are shown in Table 1

IV. Results

When critical experiments were begun—i e., reward removed—only one normal animal ran at the seventh opportunity to do so, two *ceased at the fourth opportunity* All *operated animals* (except No 3) ran even at the tenth opportunity and the twelfth found three of them still running The significance of this difference of behavior is discussed in Section VI.

The details of all "accepted opportunities" to leave *A* are given below in outline form. For the purpose of completeness the first run is also described in this outline In the summary of results which follows values taken from the first run are not included As was mentioned above, this initial run of the critical series was not "a run to an *empty* food box," for at each of the several hundred preceding runs there had always been food in *B* Tabulation of the data derived from the first critical run is therefore given in the outline merely as typical of the animals' runs prior to critical conditions (Table 2).

The failure of an animal to leave *A* or, if he had entered *C*, to go on through *Y* into *B* was characterized by a variety of individual behavior peculiarities, especially by normal animals In some cases the rat would turn around in his starting-box compartment and sit with his back to the door at *X*, others crouched at *X*, looked out but did not leave; others left *A*, wandered about in *C* and either tried to reenter *A* (which was impossible because the door at *X* was closed after the animal had left *A*) or sat down, usually in the middle of *C* The behavior was varied in each case with the exception that the *Y*-alley became a thing to be avoided. This was particularly noticeable in the case of normal animals On those occasions when the animal did find himself at *Y* he approached it very cautiously, then either darted in or else shied away. This was more noticeable during the

TABLE 2*A*

BEHAVIOR OF RATS UNDER NO-REWARD CONDITIONS

No of rat	Description of behavior	Time in secs from *A* to *B*	No of rat	Description of behavior	Time in secs from *A* to *B*
	Normal			*Operated*	
	First opportunity			*First opportunity*	
1	Ran directly from *A* to *B*	4 0	1	Ran directly from *A* to *B*	1.6
2	" " " " " "	2 3	2	" " " " " "	1 2
3	" " " " " "	3 8	3	" " " " " "	2 2
4	" " " " " "	3 0	4	" " " " " "	3 0
5	" " " " " "	1 5	5	" " " " " "	1 6
6	" " " " " "	2 0	6	" " " " " "	2 2
	Second opportunity			*Second opportunity*	
1	Directly from *A* to *B*	5 1	1	Ran directly from *A* to *B*	1 4
2	Ran directly from *A* to *B*	3 2	2	" " " " " "	1 2
3	" " " " " "	2 6	3	Hesitated in *A*	7 0
4	Searched walls and corners of *C*	14 0	4	Ran directly from *A* to *B*	1 8
5	Ran directly from *A* to *B*	2 0	5	" " " " " "	1 4
6	Directly to *Y*, stopped, then entered	6 0	6	" " " " " "	2 4
	Third opportunity			*Third opportunity*	
1	Went immediately from *A* to *Y*, stopped suddenly, turned left, pawed in corner, moved, sniffing along the crack of floor and walls, to *Y* and entered	15 0	1	Ran directly from *A* to *B*	1 6
2	Sniffed at *Y*-opening, then entered	8 1	2	Hesitated for some time at *Y*	7 4
3	Ran directly from *A* to *B*	3 2	3	Hesitated in *A*	9 0
4	Remained 15 secs in *A*, came out into *C*, rapidly sniffing over a large area of the floor (ignored walls)	47 2	4	Hesitated in *A* for 6 secs	8 0
5	Slight hesitation at *Y*	4 0	5	Ran directly from *A* to *B*	1 6
6	Left *X* at an angle, visited far left corner, entered *Y* from side	9 0	6	" " " " " "	2 4
	Fourth opportunity			*Fourth opportunity*	
1	Left *X* at an angle, examined *C* rapidly (three corners) for 9 secs., then suddenly attempted to climb over wall in which *Y* is located Bit viciously	35 0	1	Hesitated in *A*	9 4

TABLE 2A (*continued*)

No of rat	Description of behavior	Time	No of rat	Description of behavior	Time
	when picked up in *B*				
2	Investigated left walls and far corner, entered *Y* from side	10.0	2	Ran directly from *A* to *B*	1.6
3	Hesitated in *A*	10.4	3	Hesitated in *A* and at *Y*	17.0
4	Refused to leave *A* [see comments below on this and other refusals]	Nil	4	Slowly but directly from *A* to *B*	5.0
5	Dashed out to *Y*, pivoted, scrutinized walls of *C*, finally coming upon *Y* from side and entering	16.0	5	" " " " " " "	3.0
6	Refused to leave *A*	Nil	6	Ran directly from *A* to *B*	2.6
	Fifth opportunity			*Fifth opportunity*	
1	Remained in *A*	Nil	1	Ran directly from *A* to *B*	1.6
2	Left *A* at once, went directly to *Y*, sniffed, veered immediately away Stood on hind legs, peered about. Attempted to climb over a side wall. Moved across *C*, in passing regular trail from *X* to *Y*, turned suddenly, and entered *Y*	58.0	2	Hesitated in *A*	7.6
3	Remained 10 secs in *A*, went to *Y*, hesitated, entered jerkily	31.0	3	Ran directly to *Y*, hesitated	11.0
4	. .		4	Slowly and sniffing but directly	7.4
5	Explores *C*, paws in corner, happens upon *Y*, shies away, explores further, suddenly enters *Y*	20.0	5	Ran directly from *A* to *B*	1.8
6	. . .		6	" " " " " "	2.2
	Sixth opportunity			*Sixth opportunity*	
1			1	Ran directly from *A* to *B*	1.8
2	Left *A* at once, continued exploring *C*, obviously shy of *Y* and avoiding it Never entered	Nil	2	" " " " " "	1.4
3	Left *A* after 15 secs, went slowly to middle of *C*, sat down and peered about Suddenly entered *Y*	43.0	3	Hesitated in *A*, then with slow, jerky, sniffing movement directly to *Y*, which he entered after a moment's hesitation	20.0
4	.		4	Remained 30 secs. in *A*, then slowly out, sniffing the way directly to *B*	46.2

TABLE 2*A* (*continued*)

No of rat	Description of behavior	Time
5	Left *A* but avoided *Y*, frantic	23 0
6	-	
	Seventh opportunity	
1	. .	
2		
3	Remained in *A*	Nil
4		
5	Remained 12 secs in *A*, then directly but slowly to *Y*	16 0
6		
	Eighth opportunity	
1	.	
2		
3		
4		
5	Remained in *A*	Nil
6	.	

No of rat	Description of behavior	Time
5	Hesitated in *A*	4 6
6	To *B* after 4-secs delay in *A*	7 2
	Seventh opportunity	
1	Ran directly from *A* to *B*	1 8
2	" " " " " "	1 6
3	Slowly but directly to *B*	5 0
4	Directly to *B*	3 8
5	Hesitated in *A*, poked nose out several times, finally sniffed along the trail to *Y* and entered	20 0
6	Remained 6 secs in *A*, then, sniffing, proceeded to *B*	11 2
	Eighth opportunity	
1	Ran directly from *A* to *B* (bit the experimenter when returned to *A*)	2 0
2	Ran directly from *A* to *B*	1 4
3	Remained in *A*	Nil
4	Directly from *A* to *B*	4 2
5	Hesitated 8 secs in *A*, sniffing the trail, proceeded to *B*	13 2
6	Hesitated 9 secs in *A*, then to *B* slowly but directly	11 4
	Ninth opportunity	
1	Directly to *B* but difficult to pick up for return to *A*	2 2
2	Hesitated in *A*	4 8
3	. .	
4	Left *A* immediately, hesitated and sniffed around the *Y* door	8 4
5	Hesitated 15 secs in *A*, then proceeded, sniffing trail, to *Y*	23 4
6	Remained 7 secs in *A*, then proceeded, sniffing, to *Y*	10 0
	Tenth opportunity	
1	Hesitated at *Y*	5 6
2	Hesitated in *A* and before *Y*	9 6
3	.	
4	Left *A* immediately, sniffed about in *C*, but never got farther than 7 cm from the main scent-trail from *X* to *Y*	12 6

TABLE 2*A* (*continued*)

No of rat	Description of behavior	Time	No of rat	Description of behavior	Time
			5	Followed odor trail in *C* and with no great deviations from this trail; happened upon *Y* and entered directly	30 4
			6	Remained 15 secs. in *A*, then smelled about *C* for 16 secs., confining himself to parts of the floor which were more thoroughly "tracked"	31.0
				Eleventh opportunity	
			1	Hesitated in *A*	5 6
			2	Left *A* immediately, sniffed to a point 7 cm left of *Y*, then immediately into *Y*	6 2
			3		
			4	Remained in *A*	Nil
			5	Directly to *Y*	7 2
			6	Remained 50 secs in *A*, then directly to *Y*	54 0
				Twelfth opportunity	
			1	Remained 30 secs. in *A*, then directly to *Y*	33 0
			2	Ran directly from *A* to *B*	2 4
			3	. . .	
			4		
			5	Remained 22 secs in *A*, then slowly but directly to *Y*	26 4
			6	Remained in *A*	Nil
				Thirteenth opportunity	
			1	Remained 35 secs in *A*, then wandered, sniffing about, in *C* but avoided *Y*	Nil
			2	Remained in *A*	Nil
			3	. .	
			4	.	
			5	Remained in *A*	Nil
			6	. . . .	

TABLE 2B

SUMMARY OF THE ABOVE

Normal					Operated				
No of rat	No of opps taken*	No of opps not taken‡	Former average speed (secs)	Average speed for opps taken (secs)	No of rat	No of opps taken*	No of opps not taken‡	Former average speed (secs)	Average speed for opps. taken (secs.)
1	3	9	4 2	18 4	1	11	1	1 9	6 0
2	4	8	2 5	19 8	2	11	1	1 8	4 1
3	5	7	6 5	18 0	3	6	6	10 4	11 5
4	2	10	4 4	30 6	4	9	3	3 8	10 8
5	6	6	2 1	13 5	5	11	1	2 1	12 1
6	2	10	5 3	7 5	6	10	2	2 8	13 4

*Not counting the first run, for this was to all intents and purposes merely the 6th of 5 preceding (rewarded, introductory) runs (See Section II, ¶ 3)

‡Since the first run is not counted and the total number of *opportunities* catalogued above is 13, the number of actual runs made by any animal cannot have been more than 12 inasmuch as the last (i e, 13th) opportunity was *not taken by any rat The fact of all animals ceasing to go into B was, of* course, what brought the series to a close for so long as any animal remained who was still entering *B* when given the opportunity to do so, just that long would the process of giving him this opportunity have continued Since, however, even all operated rats failed to take the 13th opportunity (as shown by the foregoing résumé), we find that the maximum number of opportunities actually taken was 11—which was the case with rats Nos. 1, 2, and 5 in the above "operated" column Normal rats were not returned to the starting-box 13 times When "Nil" appears in the time column this marks the fact that that particular animal failed to run and was therefore not reintroduced into the foodless situation during the series here catalogued

TABLE 2C

SUMMARY OF SUMMARY

Behavior	Normal	Operated
Opportunities taken	3 66	9 66
Opportunities not taken	8 33	2 33
Former speed (in secs)	4 16	3.80
Speed for opportunities taken (in secs)	17 58	9 61

later opportunities and occurred more frequently on the part of normal than of operated rats Several times (especially with the normal animals shortly before stopping altogether) the rat would leave *A*, run across toward *Y* and veer away as if an electric shock had been given him. Again, a rat would come into *C* (perhaps after delaying for several seconds in *A*) and begin moving about until by chance

he came in line with *Y*. This was frequently, though not always, sufficient to "draw" him into the *Y*-alley.

Most noticeable of the many differences between the behavior of normal and operated animals in the no-reward situation was their "attitude" toward *C* Normal animals seemed much more obviously in search of food than operated animals. Careful check upon the *amount of food consumed*, weight, and general physical condition assured the experimenter that the animals had been hungry even when refusing to run from *A* to *B*. Conclusive evidence of this was given by the fact that they ate heartily and readily *after* the critical experiments. In this, as in all other features of the experiment, every effort was made to establish identical physical conditions for both groups. Normal and operated rats were hungry at the time of critical tests. Nevertheless, whereas *C* (for normal animals) was apparently a place to seek food after *B* had proven foodless, for operated rats *C* was merely a place to cross in order to reach *B* When, however, the *A*-to-*B* unit had practically disappeared for operated rats, *C* appeared to function as a new thing, partly familiar perhaps, yet at the same time, fearsome. That if food was not forthcoming at the customary place in this erstwhile familiar situation, it might be sought elsewhere does not seem to have been an alternate mode of behavior for operated rats nearly so much as it was for normals. On the other hand, however, that the whole former situation no longer prevailed—that this was no longer a "familiar situation" at all—seems to have appeared to normal rats comparatively early. When food was available in *B*, running from *A* to *B* was apparently a natural behavior unit for both groups. When food was missing and normal animals had ceased running while operated ones continued (e g., eighth opportunity *et seq.*) the only plausible supposition would seem to be that the behavior of the *operated* rats was more determined by the former behavior pattern than was that of the normal animals. Consideration of these and related aspects of the results will be taken up in detail in Section VI

V. Control Group

In order to investigate the possible effect upon normal animals of the 14-day period of rest (during which the animals of the experimental group were recuperating), as well as the 143 additional trials subsequent to this rest period, a control group of 9 animals was given the same training as that received by the experimental group On the

TABLE 3
NUMBER OF OPPORTUNITIES TAKEN

Rat	1st Experiment	2nd Experiment
c1	5	3
c2	4	4
c3	2	3
c4	4	4
c5	3	4
c6	4	7
c7	3	5
c8	4	2
c9	5	6

first occasion of non-appearance of food in *B*, these animals accepted from 2 to 5 opportunities to enter *B* after discovering that it contained no food. Their average was 3.8 opportunities accepted. On the occasion of the second critical experiment (after 14 days during which no experimentation took place, followed by 143 additional trials) the group accepted from 2 to 7 opportunities, the group averaging 4.1 There was no observable difference between the behavior in the first and second critical experiments, and the time differences were equally insignificant. Table 3 is a summary of the control group runs.

VI. GENERAL COMMENTS

1. Much, but not enough, has been written in psychology regarding the advantages of studying subjects under "natural" conditions. Several successful investigations have been reported but difficulties not infrequently arise One finds, for example, that many a "natural" condition ceases to be natural when the experimenter intervenes; or, that to devise suitable interferences obstructing a natural sequence of behavior events is well nigh impossible or does not yield measurable results. To overcome this obstacle it is necessary to permit the animal not only to "learn" a given task, but to become so familiar with it that he has himself, "quite naturally," made the response genuinely "his own" The obvious importance of this need not be further emphasized here [3]

In this experiment one was able to observe the upset of a natural sequence of behavior acts It is immaterial whether such sequence be called a *habit* or not. The point at issue is that the animals were

[3]For an excellent illustration see Kohler (3, esp p 26)

doing something with which they were thoroughly familiar and that then an obstruction was encountered. The experimenter established in the rats a readiness to run from A to B when hungry The animals were not "trained", they were, instead, repeatedly placed in a constant environment affording an opportunity to explore the same and to secure food therein They were thus permitted not only to familiarize themselves with the floors, walls, corners, etc, but also to employ all muscles and sense organs in whatever way might normally occur.

Hungry rats, thoroughly familiar with the conditions of obtaining food under these circumstances, move from A to B as if X, C, and Y were not present It seems reasonable to assume that these physical connective links are *not* "present" for the rat in this case any more than the muscles of his body when running are "present" for him. He is at A and wants to be in B If intervening conditions are familiar, we may say that for him A and B are fused into one dynamic, vectoral unit Being placed by the experimenter in the starting-box, A, means food to him, just as much as being placed directly into B would have. This arrangement of boxes and doors is the "food situation," and he *is hungry*.

2. We have called the A-to-B behavior a pattern or unit and spoken of its fusion into one dynamic, vectoral unit It becomes incumbent upon us now to defend this description and indicate what it implies.

There are two ways of looking at the fact that rats run from starting-box to food. Were a moving picture of this to be made, the film cut, and the separate pictures inspected individually, *one* type of *view regarding the A-to-B run would be obtained Considered in* this light, elimination of the last few pictures should not change the images disclosed upon the earlier ones. We find, upon considering the animal's behavior during the second, third, and fourth opportunities, however, that something seems to have happened to change each early stage and that his conduct in C (for example) is fundamentally different from what it was prior to having found no food in B It is this fact, this operation of one aspect of the original situation upon the several other discriminable aspects of it, which leads us to feel that a description is demanded that will refer to these many aspects taken together as one unit or thing

The question naturally arises, *How* did Situation I (i e., darting from A to B) disappear? The rat did not first dash from A through

the Y-alley up to the door of B and stop, then do the same as regards the Y-alley entrance, and so on, such as one might have him seem to do by cutting a moving-picture film at these points. We find, instead, that every phase and aspect of the situation seems to have been different for him after one or two fruitless visits to B. This can be described in two ways: (*a*) Either Situation I vanished entirely and a fairly chaotic, frightening, unfamiliar Situation II succeeded to its place, or (*b*) Situation I gradually gave way, gradually disintegrated until the resulting situation was so different, contained so many relatively self-subsistent aspects that we are no longer privileged to speak of Situation I as present, though loosely and badly organized, but must suppose Situation II to have supplanted it.

Both of these possibilities would allow for the fact that after B has proved foodless Behavior I no longer prevails. It must be, therefore, from a closer scrutiny of Behavior II that we should decide upon the structure and nature of Situation II. To do this, it will be necessary for us to consider somewhat more literally the fact that one discernible aspect of either situation is the *rat* itself. The human onlooker can see A, X, C, Y, B, and rat as six separate items. We are not justified, however, in assuming that the rat sees things this way. As a matter of fact, we are concerned here, as elsewhere in this report, to avoid any assumptions whatsoever regarding the animal's side of the matter. Experimental data objectively assembled provide adequate information. We are merely interested in attempting to interpret and understand these data and ascribe no more to their origin than one would do had they been derived from a non-living source.

Viewed by a human being it would seem plausible to say that a rat (one item) is running from A through X, C and Y into B (other items), or that the rat is engaged in traversing an A-X-C-Y-B pathway. In contrast to this assumption, however, we are probably describing the matter more accurately if we say that the situation is "*a n i m a l*" in-and-of "$A\ X\ C\ Y\ B$." In order to have a symbol for this, let us combine the letters thus "$_aA_nX_iC_mY_aB_l$." If this is a relatively undifferentiated unit, then it should be apparent why disturbance of B would invoke modifications throughout the system and perhaps so alter the same as to bring about its disappearance.

We maintain that if—and only if—the behavior sequence was a genuine $_aA_nX_iC_mY_aB_l$ whole (as above defined) can the difference in behavior between normal and operated rats be explained or under-

stood. As shown in Section IV, the disappearance of Behavior I took place *differently for the two groups*. Objective evidence that in both cases ${}_aA_nX_tC_mY_aB_t$ is a dynamic, vectoral unit is discovered in the following facts: (*a*) It did not break up like a house of cards, the individual units of which are essentially independent of one another, (*b*) it did not merely drop B as in the moving-picture illustration above, (*c*) it exhibited, rather, an inner tension which persisted in such fashion that the behavior prevalant before B was objectively *modified continued in most cases (especially after operation) to go off* for some time despite that modification, (*d*) finally, ${}_aA_nX_tC_mY_aB_t$ revealed itself to be a genuine whole in that, when disturbance at one point *did* express itself effectively, the result was apparent throughout the entire system

3. Comparing the results before and after operation we find that, relative to the same physical environment, the average deviation of a *certain rat's normal runs is less than that of the same animal after* operation (see Table 1) That is to say, with but one exception (No 3), all operated rats were more constant in their behavior than the same animals had been when normal It seems not unnatural for us to anticipate some corresponding difference in behavior when a problem is encountered. It appears, in other words, that a behavior unit, once it is adopted by an operated rat, does not so readily disappear as is the case with normal animals When ${}_aA_nX_tC_mY_aB_t$ has been established (i e., when Behavior I prevails) and food is removed from B, the rat (whether normal or operated) is confronted with a problem The correct solution of this problem lies in abandoning Behavior I, which is another way of saying that to solve the problem is to become released from the implications or requirements of Situation I and behave in a manner required by and befitting Situation II. To accomplish this the rat must be to that extent docile[4] that features of the new physical conditions can exert their influence upon his behavior. If he persists in imposing Behavior I upon Situation II we are justified in saying that for him Situation *I* still prevails, or, in other words, that the features of Situation II have not as yet succeeded in finding expression through the rat's behavior All of which is but another way of saying that he has not solved the problem. Evidently, to solve a problem requires insight into the presented situation, but, unless the situation *is* "presented," insight into it cannot occur.

[4]For this use of the word see Tolman (4, p 14)

It is presumed that a hungry rat's hunger *drives* him to seek food and that this requires adopting a behavior which will yield food[5] Or, in other words, that the propulsive energy of ${}_aA_nX_iC_mY_aB_l$ is derived from the hunger in its mobile aspect (viz., *"a n i m a l"*). This was very clearly exhibited by the normal animals for when B proved "foodless" the *"a n i m a l"* aspect of ${}_aA_nX_iC_mY_aB_l$ was, so to speak, *released* and they sought elsewhere (notably in C—although they had never been given food in C) What the normal animals achieved and the operated animals did not achieve was release from the A-to-B behavior pattern after relatively few failures to find food in B.

4 As a means of indicating the difference between normal and operated animals when confronted by the problem just mentioned, we propose that the two be classified as exhibiting different degrees of *behavior constancy*. Interrupting the discussion for a moment, let us consider an example of behavior constancy.

> Rat No 7 (not reported above) was the wildest of the original colony At the slightest opportunity he would escape from his cage and was on all occasions almost impossible to handle After operation this was reversed No signs of wildness remained and no effort was made to escape Indeed, he had become so phlegmatic that the experimenter, wondering if motor coordination was intact, lifted the animal from his box (shoe-box size) and placed him on the floor at ½ meter distance This was 10 days after operation The animal had retained vision, and apparently sense of smell as well, for he at once moved, sniffing along the floor, toward the box, crawled up over its edge and in Several days later this experiment was repeated with the same result
>
> Twenty days after operation the following systematic series was undertaken
>
> *a* It was found that the rat could find his way back to the box from any point within a radius of 1 meter when the box was placed in the center of the room (i e, no guide such as running along a wall was possible)
>
> *b* A normal rat was placed for 72 hours in a similar box, then both normal and operated animals removed, placed one meter from their boxes, and the respective behaviors observed[6] The normal rat began a hasty investigation of the room, moving for the most part away from the box and, in general, seemingly unaware of, or indifferent to, its presence No 7

[5]See Tolman (4, 5)
[6]Moving pictures were taken of this

went directly to his box and climbed in Four seconds after the experiment began No 7 was already in his box, 25 seconds later the normal animal had reached the far wall of the room and showed no signs of behavior that would lead back to the box

c. The next experiment with No 7 consisted in allowing him to reach his box by returning with the wall as guide Using different walls and different rooms the animal was placed beside the baseboard, the box also next to this wall, and record kept of the distance from which he was able to return From any distance within 3 meters the return was prompt and smooth

d A wide (indoor) staircase was used for the next experiment[7] The animal was placed 3 meters from his box, right shoulder to stair rise, and permitted to return 5 times along the same path (A new stair-step was used at each return) Upon the sixth opportunity the rat was carried not 3 but 4 meters away Instantly, upon being set down, he ran in the direction of the box precisely 3 meters and stopped There ensued a most obvious seeking behavior. He sniffed about, left the wall but quickly returned, reared up and tried to climb over the step as if it were the box, failed, sniffed again, and then moved slowly along with right shoulder against the stair rise and thus finally to his box which he entered immediately after a few preliminary sniffs along its side. The hesitation at the 3-meter distance lasted 8 seconds This experiment was repeated on different days with the *same* results each time.

At no time was the animal given a food reward upon return to his box The experiments above reported were carried out under varying conditions of hunger—from very hungry to satiation—and showed no quantitative or qualitative differences whatever Further investigations of hunger in the case of this rat were made as follows. It was discovered that he would not eat at any place but in his own box Once his familiar food dish was placed on a low table 25 cm from his box and the animal allowed to go for 48 hours without food, yet he did not leave his box to reach the dish On several occasions at his customary feeding time (evening) he was placed (after 24-hour hunger) in another box with food, but he refused to eat[8] When

[7]This was done to assure practical identity of general environmental orientation while, at the same time, allowing a new "wall" to be used for each return so as to avoid odor cues.

[8]A similar case with chickens is reported by D Katz (2)

taken from his box and allowed to return, the rat was often forced to run across sunflower seeds, but at no time did he stop, even when very hungry, to eat these but seemed oblivious to them in his desire to reach the box

5 The case of rat No 7 has been mentioned as illustrating what we understand by the term "constancy of behavior." Behavior constancy means crystallization of a behavior pattern.[9] A behavior pattern is a sequence of behavior acts the inner relationships of which are such that all are to greater or less extent determined by the dynamic vector of their mutual whole series *qua* whole—i e, the "*Gesamtverlauf.*" So long as ${}_aA_nX_tC_mY_aB_t$ prevails, no differentiation of parts can be observed. Or, in other words, so long as the rat runs at maximum speed from A to B, we may assume that the behavior pattern ${}_aA_nX_tC_mY_aB_t$ is dominant. If this behavior unit is of such stability that neither "*a n i m a l*" nor A, X, C, Y, B, or any combination of these, stands out as an independent unit, then events running the course dictated by the structural nature of such unit continue unchanged The degree of stability may be determined by introducing changes in either "*a n i m a l*," A, X, C, Y, or B[10] The unit has a relatively high degree of stability if its persistence energy[11] overcomes modifications in those physical aspects. The greater the physical change over against or despite which the unit persists without upset, the greater has that unit exhibited its stability. Or, what is more to the point, the greater the stability of ${}_aA_nX_tC_mY_aB_t$ the less likely is "*a n i m a l*" to be released therefrom. If the internal persistence energy of the behavior pattern is able to overcome and compensate for changes such as removal of food from B, then it is apparent that the behavior pattern was to a fairly high degree crystallized and the case may be referred to as one of relatively great *behavior con-*

[9]That the pattern does not require identity of physical conditions in order to run its course is evident from the behavior of No 7

[10]It is not to be assumed, of course, that each discriminable aspect of the ${}_aA_nX_tC_mY_aB_t$ whole will, should it be altered, have the same effect upon that whole which change in any other aspect would have The experimenter selected an aspect of the whole which *he* was able to discriminate from the others and introduced a radical change at that point (i.e., omitted to put food in B) It became apparent from subsequent modifications of behavior that B was probably a key-aspect of ${}_aA_nX_tC_mY_aB_t$ It lay outside the range of this experiment to enquire what rôle other discriminable aspects of the unit played

[11]A term adapted from E C Tolman's "persistence until" as regards behavior

stancy. The effect of behavior constancy upon the ability of these rats to solve a problem has been demonstrated.[12]

VII. Conclusion

If it is true that to solve a problem requires insight into the presented situation, then *behavior constancy militates against insight.* To get an insight into the *non*-existence of a condition or relationship would seem to require "negative" insight as distinct from the "positive" insight through which the effectiveness of a present relationship is expressed. Thus we may say that the fact of Behavior I being abandoned was a "negative" prerequisite for subsequent dominance of Behavior II, since, in so far as Behavior I persisted, the adopting of Behavior II was correspondingly delayed. It is the persistence of a (former) behavior unit that is here characterized by the term *behavior constancy* Hence it may be asserted that behavior constancy delays or prevents insight.

References

1 Gelb, A, & Goldstein, K Zur Psychologie des optischen Wahrnehmungs- und Erkennungsvorganges *Zsch. f d ges Neur. u Physiol*, 1918, 41, 1-142

2 Katz, D. Hunger und Appetit *Ber. u d XII Kong. d dtsch. Gesellsch f. Psychol*, 1931.

3 Kohler, W Nachweis einfacher Strukturfunktionen beim Schimpansen und beim Haushuhn. *Abh d. preuss. Akad d. Wiss, Phys-math Kl.*, 1918 S 101

4 Tolman, E C Purposive behavior in animals and men New York Century, 1932. Pp. xiv+463

5 Tolman, E. C., Honzik, C. H, & Robinson, E. W The effect of degrees of hunger upon the order of elimination of long and short blinds. *Univ. Calif. Publ. Psychol*, 1930, 4, 189-202

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[12]*No evaluation is implied by the term behavior constancy* The question whether it may not have definite advantages under certain circumstances lies outside the scope of our present discussion Cf, however, Gelb and Goldstein (1, esp pp 62 f)

LA CONSTANCE DU COMPORTEMENT CHEZ LES RATS

(Résumé)

On a permis aux rats blancs d'aller d'une boîte de repère par un petit couloir et un grand espace libre à de la nourriture placée au bout d'un second couloir, en face de la boîte de repère Après qu'ils avaient appris à fond la situation, on leur a permis d'aller à la nourriture 400 fois de plus Une expérience critique a consisté en l'enlèvement de la nourriture de sa position usuelle On a noté le nombre de fois que les rats sont allés où la nourriture avait été auparavant, et aussi la durée de chaque essai et le comportement général Après cela, on a détruit des parties corticales, et on a appris encore une fois la première situation aux rats On a fait une second expérience critique, semblable à la première.

Avant l'opération, les rats on accepté une moyenne de 3,66 occasions d'aller à l'endroit où ils avaient trouvé de la nourriture auparavant Après l'operation, ils ont accepté plus de deux fois le nombre d'occasions, et on a noté les différences de temps et de comportement géneral. On a soumis un groupe de contrôle au même entraînement et aux mêmes expériences critiques, mais on n'a pas opéré les membres de ce groupe On n'a noté aucune différence entre le comportement de la première expérience et celui de la seconde.

Ces résultats indiquent que la déstruction des parties corticales tend à rendre le comportement plus fixe et moins sujet à la modification comme résultat de changements du milieu On a suggéré qu'on se sert du terme "constance du comportement" pour cette cristallisation de la forme du comportement HAMILTON ET ELLIS

VERHALTUNGSKONSTANZ BEI RATTEN

(Referat)

Es wurde weissen Ratten erlaubt, von einer Startkammer aus, durch einen kurzen Pfad und einen grossen offenen Platz, Futter zu erreichen, das am Ende eines zweiten Pfades, der Startkammer gegenuber, lag Nachdem ihnen die Lage vollig vertraut war, liess man sie noch 400 Mal zum Futter laufen Ein kritischer Versuch bestand darin, dass man das Futter von seinem gewohnlichen Platz entfernte. Man notierte (1) wie viele Male die Ratten zu dem Ort hinliefen, wo vorher Futter gewesen war; (2) die zu jedem Lauf notwendige Zeit, und (3) das allgemeine Verhalten. Nachher wurden dann Teile der Hirnrinde zerstort, und die Ratten wieder mit der ursprunglichen Situation vertraut gemacht Es wurde ein zweiter kritischer Versuch ausgefuhrt, der dem ersten glich

Vor der Operation nahmen die Ratten durchschnittlich 3 66 Gelegenheiten an, zu dem Ort hinzulaufen, an dem sich das Futter fruher befunden hatte Nach der Operation wurden mehr als zweimal so viele Gelegenheiten angenommen, und es wurden auch wesentliche Unterschiede in Bezug auf Zeitverbrauch und allgemeines Verhalten festgestellt Eine Kontrollgruppe erhielt dieselbe Dressur und dieselben Prufungen, wurde aber nicht operierte Man bemerkte bei dieser (Kontroll-)gruppe keinen Unterschied zwischen dem Verhalten in den ersten und zweiten kritischen Versuchen

Diese Befunde wiesen auf, dass Zerstorung von Teilen der Hirnrinde dazu neigt, die Tatigkeit starrer zu machen, und sie der Modifizierung durch Anderungen der Umgebung weniger zuganglich zu machen Es wird vorgeschlagen, dass der Ausdruck "Verhaltungskonstanz" auf diese Kristallizierung der Tatigkeitsgestalt (pattern of behavior) angewendet werden soll HAMILTON UND ELLIS

PERSISTENCE AND BEHAVIOR CONSTANCY*

From the Psychological Laboratories of the University of California

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I. Introduction

In an earlier report (2) the writers suggested that continuance of a behavior unit (Behavior I), despite changes in the environmental supports such that a modified behavior (Behavior II) would be more appropriate, is evidence of *behavior constancy.* There is, however, some danger that this term be confused with *persistence* If it is true, as we believe, that behavior constancy is a genuine psychological phenomenon, refinement of its definition—such, for example, as indicating the distinction between these two—is eminently desirable. It is the purpose of this paper to present the results of an experiment wherein certain differences between behavior constancy and persistence are demonstrated.

The behavior of normal and operated rats in two situations has been studied.

II. Apparatus and Procedure

1. As shown in Figure 1, an uncovered box, 30 cm. long, 20 cm. broad, and 25 cm. high, through a small hole in the bottom of which an endless string passed, constituted the apparatus used The string was 3 25 m. long and passed over three pulley wheels, as indicated in the drawing.

2. Eleven white rats, all males, age 90 days at the beginning of this study, were used. Before training began, five were operated upon and parts of the cortex destroyed by the thermocauteric method. Ten days after operation the training began

The diet consisted of sunfloweer seeds (10 per day, as described below) and a modified Steenbock diet.

3. Preliminary procedure was as follows· The animal was placed in the box and allowed to familiarize himself with it. A sunflower seed was split and fastened to the string just within rearing reach of

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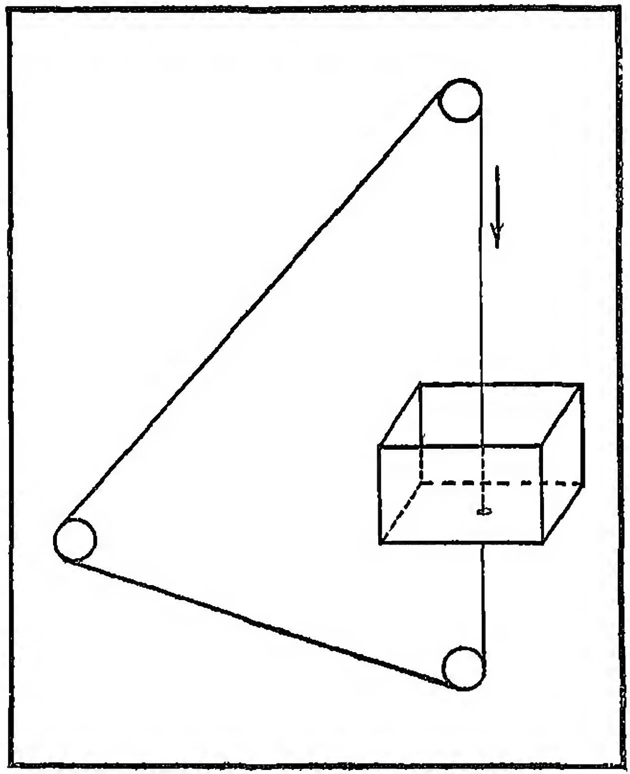

FIGURE 1
Diagram of the Apparatus

the rat[1] In the course of his investigations the animal eventually found the seed. Being hungry, and having formerly been fed these seeds, he readily ate Within a few trials all rats were pulling the seeds a few centimeters toward the floor before attempting to remove them. String pulling seemed to be readily and naturally acquired by all rats. The distance from seed to floor was gradually increased, until at the end of the sixth day it was 40-50 cm. This

[1] A sunflower seed will split open like a clam shell and retain a certain elasticity so that, when this opening is brought against a small cord and the seed released, it clamps itself thereon

distance was continued throughout subsequent training, as described below.

4. The animals having thus learned to secure food in the manner described, a training series ensued as follows. Each day for 18 days the rats were allowed to pull in 10 seeds There were two periods, morning and early afternoon; 5 seeds were pulled at each period. The animals were all rapid and accurate before the 18 days had elapsed. Immediately upon being placed in the box all rats would approach the cord and begin pulling

III. Test Situations

I In *Experiment A*[2] the animals of both groups were placed in the pulling-box, but no seeds were attached to the string A record was kept of the *amount* of string pulled by each rat, and of time involved General characteristics of the animal's behavior, such, for example, as apparent energy of attack, attempts to escape from the box, etc, were also recorded The experiment for each animal was arbitrarily terminated when a period of 5 min. elapsed during which the rat did not resume pulling activity.

2. Following *Experiment A* preliminary training procedure was resumed for 7 days (70 pulls). In *Experiment B* the animals were not hungry, as they had been in all their previous experience with the pulling-box, but were first satiated with food and then placed in the box. This time a seed was attached to the string at the usual distance, and a record was kept of the number of seeds pulled in and eaten. In this case the animal was allowed to remain for 5 min in the box and was then removed.

After an interval of three days during which the regular diet and pulling regime were resumed Experiment B was repeated.

IV Experiments and Results

1. *Experiment A*. After 18 days of preliminary training the rats had become so familiar with the string device for obtaining food that, immediately upon being placed in the box, they would catch hold of the string and secure the seed Being placed in the box upon

[2]By the term *"Experiment"* is meant "Test Situation" or "Critical Situation" Since the present report is not concerned with learning in the sense customarily used in reports of animal study, but rather with questions which arise only after habit formation, the progress of the investigation up to this point may be viewed as preliminary training, or familiarizing

the occasion of what the experimenter knew to be the "critical experiment" was apparently in no sense anything unusual for the rats They went immediately to the cord and began pulling There was no observable difference between the behavior of operated and normal rats in this prompt response to the familiar situation. Nor does there appear to be any marked difference in the pulling itself There were pauses and resumptions on the part of all animals. The notations recorded in Table 1 indicate, in fact, that the kind of behavior was throughout very similar The difference between operated and normal rats lies not in the *manner* of behaving, but in the results achieved normal rats pulled in more string during a longer period of resumptions in pulling than was the case with operated rats.

Rather than overburden the statement by reproducing the entire account of each rat's behavior in Experiment A, let us consider instead the details of a typical case, such as Rat 2 The following chronicle is taken directly from the observer's notes made during the experiment

Rat 2 is placed in the pulling-box, he attacks the string and pulls very rapidly for 30 sec , stops for an instant, and resumes pulling He has been in the box for 1 23 min , nearly 5 m of string having been pulled in He stops again for a few seconds, resumes pulling, stops and goes to one corner of the box where he scratches for an instant Now he returns to the string and resumes pulling, stops, pulls again very rapidly Total string is now 9 75 m., total time 2 30 min Stops He tries to climb a wall of the box, fails, and returns to the string—in 15 secs.—he pulls another 1 50 m , stops, attempts to escape, returns to string and takes hold of it but does not pull. He again tries to climb the wall He returns to the string; takes hold of it but does not pull Time elapsed since last pull at the string is now 1 min , total since being put in the box, 4 00 min He attempts to escape, returns to the string, takes hold of it, and suddenly begins to pull with great vigor At a total time of 9 30 since entering the box he has now pulled in 18 50 m of string The burst of pulling (which had continued for a little over 4 min) stops as suddenly as it began and with an equal display of energy, he attempts to climb the walls The behavior is now becoming slower Time since last pull is 1 min, total time in box is 10 42 min He tries to bite the cord but does not take hold of it with his paws Again bites at the string and suddenly rears and begins pulling This pull finished at a total time of 12 02 min and lasted 6 sec, after

which attempts to scale the wall were resumed. At a total time of 14·08 the behavior is slow, much of the time during the past two minutes the rat has done nothing but sit. It is now 3 min since the last pull and 15 08 min since entering the box. At the end of the 4th min the rat sits and does not move again At a total time in the box of 17 08 min, the 5th min since his last pull is up, and the experiment declared completed.

The rat is removed from the box and placed in a receiving cage. The total amount of string pulled was 19.30 m.; time of *final* pull was 12 08 min after entering the box.

The amounts of string and time, as well as averages thereof, are indicated in Table 1. It will be observed that the averages of normal rats exceed those of the operated in regard both to meters of string and length of time during which pulling was being periodically resumed The column *Time* refers to the total number of minutes elapsed between the time when the animal was placed in the box and the last occasion of his pulling. If the normal and operated averages appearing in this column are compared it will be observed that the time (of final pull) for the former is 15 35 min, whereas that of the operated rats is 8·58 min Examining the averages of string pulled, we find that normal rats exceed the operated in this respect also, for the difference here is 18.91 m. for normals as against 11.34 m. for the operated group.

It might be objected, however, that these differences supply no grounds for psychological conclusions, inasmuch as operated rats were perhaps physiologically incapacitated by the operation. Two

TABLE 1

Normal rats			*Operated rats*		
Total string*	Rat	Time†	Total string*	Rat	Time†
37 86	5	31.15			
23 32	1	16 10			
19 30	2	12 08			
15.20	3	17·29	14·70	x2	7 09
10 28	4	7 40	14 04	x1	9 54
7.50	6	8.47	13 80	x5	14 10
			7 82	x3	3 43
			6 52	x4	9 55
Averages					
18.91		15 35	11 34		8.58

*Rats are arranged in the order of amount of string pulled
†Time of final pull—5 minutes before removal from box.

considerations will readily show that this objection is without weight. In the first place, physical incapacity need have no effect upon the length of time actually spent in the box. An operated rat no less than a normal one could easily have resumed pulling if the drive motivating him to do so had been as strong as that activating the normal animals.[3] There seems to be no great physical exertion necessary for the rat to approach the string and pull it after some minutes of indifference since the last pull. Operated rats were undoubtedly as *able* (physically) to resume pulling as normal animals were. In the second place, we may compute from Table 1 that the *speed* of pulling was even slightly greater in the case of operated than of normal rats. Whereas normal animals pulled at a rate of 1 23 m. per minute during their stay in the box, operated rats pulled at a rate of 1 32 m. per minute The difference is not great, but, in the light of an objection based on physical incapacity, the fact that operated rats pulled not only as fast but slightly faster than the normal ones attains to added significance The objection appears therefore of little or no importance

2 *Experiment B* For seven days following the experiment just reported the rats were returned to pre-experimental conditions. As 10 seeds were pulled in each day, this period comprises re-emphasis upon the pulling-and-reward technique to the extent of 70 trials On the morning of the eighth day the rats were given their usual 5 pulls, thus bringing the total to 75 That afternoon, however, they were fed in the home cages. To secure a condition of complete food satiation a technique suggested by Katz (3) was used This consisted in presenting a variety of foods one after the other The order was. ground corn, brown bread, milk, cheese, meat, and sunflower seeds The animals had previously been familiarized with all these foods. The food was presented over a period of 2 hours and in such a fashion that, after one kind had been eaten until it was no longer touched, remaining portions were removed and the next presented As reported by Katz (regarding chickens) it was found that, upon being presented with a new food, eating recommenced. The rats had been normally hungry, having had only 5 sunflower seeds in the preceding 20 hours They ate, however, readily and greedily There can be no doubt that they reached food-satiation.[4]

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[3]A fuller discussion of this point occurs in Section IV below

[4]Rat 6 died of overeating

TABLE 2

RESULTS OF EXPERIMENT B

	Seeds pulled during 5 minutes	
Normal rats	*First trial*	*Repetition*
1	1	0
2	2	0
3	2	0
4	2	2*
5	4	0
6	1	(died)
Operated rats		
*x*1	5	3
*x*2	5	1
*x*3	1	0
*x*4	4	4
*x*5	5	7

*Two seeds were pulled, but neither was eaten

As soon as they would eat no further of the last object offered (sunflower seeds), the rats were placed in the pulling-box. A seed was affixed to the string in the usual manner. Each rat was left for 5 minutes in the box

The results of this experiment are given in the column of Table 2 marked *First trial.* Both normal and operated rats pulled in and ate seeds but more were secured and consumed by the operated than by the normal group. The average is 4 seeds per rat for the operated group, 2 seeds each for the normal group. Three operated animals pulled in and ate 5 seeds each; 2 normal rats stopped after having pulled in 1 seed each

3. *Repetition of Experiment B.* For three days the rats were again returned to pre-experimental conditions in respect both to string pulling (10 seeds per day) and time and amount of feeding. On the afternoon of the fourth day they were again fed to satiation as described above The foods given were: lettuce, wheat grains, milk, ground corn, brown bread, meat, and sunflower seeds

The right column of Table 2 presents the results of this experiment Normal rats ate nothing. Rat 4 pulled in 2 seeds but did not eat them Operated rats, on the contrary, averaged 3 seeds each The significance of these results and comparison between them and the findings of Experiment A will be discussed in the following section.

V. General Comments

We believe that there is a fundamental distinction between the phenomena of *persistence* and *behavior constancy,* and suggest that Experiment A illustrates the former while Experiment B presents a case of the latter

1. That behavior is "persistent which occurs relative to a goal." The organism may proceed in one way or another, directly or by some roundabout path, he may employ tools or rely upon his native capacities in cruder ways—but in whatever "dimension" (4, esp Chap. VII) the behavior occurs, the fact that it is goal-seeking will supply an introductory clue to its probably "persistent" character. The thing sought remains unchanged but means for obtaining it may vary through a wide range of possibilities In Experiment A, to speak of the rats' behavior as "constant" would seem not only inappropriate but false Behavior constancy is a phenomenon having to do with a relatively fixed or crystallized sequence of *behavior acts* such that the whole thus constituted comprises a self-identifiable and relatively undifferentiated behavior *unit* This unit functions as one thing and, if disturbed at any point, the effect of that disturbance is noticeable throughout the unit *Persistence,* on the contrary, is that behavior summoned by an urge, drive, or desire, and is so disposed as to further satisfaction of the same. The actual *behavior* may vary from moment to moment or from trial to trial. The goal sought, as well as the desire to attain it, are relatively stable, but the bodily movements or other "dimensional" devices are not only unfixed but may indeed be occurring for the *first* time upon this occasion Let us reconsider the foregoing experiments from the viewpoint suggested by these preliminary distinctions

2 The goal of a hungry rat is hunger satiation. Finding himself in the pulling-box and familiar with its conditions, the rat's immediate response is to pull in string If a seed is not at once forthcoming he pulls again [5] The way to food has always lain *via* pulling and hence

[5]This could not have been said on the basis of observations made during the preliminary training but can be asserted after the records of Experiment A had been assembled So long as a definitely limited unit of behavior (i e, pulling in one seed) was all the rat was required to employ, there is no way of distinguishing between persistence and behavior constancy in the going-off of this unit When, however, the unit's occurrence fails to yield satisfaction of the drive (in this case, hunger) motivating its appearance, the question then is whether or not the unit will reappear and, if so, for how long.

the activity continues. The goal sought is gratification of hunger There is a *definite and familiar pathway, viz*, the *string*. The case is not unlike an hypothetically endless maze. If an animal has learned to rely upon a certain activity in order to secure food, all he knows of the relationships between pathway and food is that after following through on one he secures the other.[9] Though it would be hard to say this with assurance of mazes in which the length of path *remains constant, the pulling-box employed in this experiment might* be thought of as a "maze" with a well-known but indefinitely extensive true path The animal is prepared to pull string for food and, in fact, as the experiment has shown, prepared to pull many meters of string if necessary The manner of doing this requires no very great variety of technique and each rat had quickly adopted his own devices for getting the seed as rapidly as possible To reach the goal of hunger satiation meant following the only possible path afforded by the apparatus used. Had the pulling-box conditions been such that food would have come with, say, the 18th meter of string, normal rats would (on an average) have secured food, while operated rats would have gone hungry The thing that is *persistent* is not the behavior unit but the drive invoking behavior in the service of its own ends.

Summarizing thus far, it may be said that "persistence" is a term to be used of drives, "behavior constancy," as the name implies, refers to behavior. If a drive is constant and we wish to designate this fact, we may speak of persistence, whether the observed behavior is of a fixed pattern or varies through a wide range of modifications Roughly, a case of this sort where "the drive's the thing" will call for the term *persistence* even though we may say that "the behavior was persistent" Since drives cannot be observed directly (1), it may be expected that reference will usually be to the behavior, as in the phrase just quoted. Nevertheless, employment of the word persistent indicates that reference to a characteristically goal-seeking sequence or hierarchy (4, Chaps XII and XX) of behavior acts is meant. Whether there be whole units in the behavior or not is immaterial in so far as a drive, inferred from goal-directed behavior, is the topic in question.

3. If Experiment A illustrates and, in doing so, helps to define the term persistence, Experiment B serves not only to elaborate fur-

[9]Experiments of this sort were reported in 1922 *et seq* by Prof W S. Hunter

ther upon the phenomenon of *behavior constancy,* but, by contrast with A, enables us to secure a clearer notion of what that phenomenon involves.

The question which Experiment B was designed to investigate may be at least partially answered by a comparison of the figures given in the left and right columns of Table 2. A rat who has had the experience of being fed to satiation and placed in the pulling situation and finds it to be, now as formerly (i e, during training), a *food* situation is in a position to *alter* or *not to alter* his "pulling-box behavior" upon a subsequent occasion of being satiated and placed in that box By altering the behavior is meant not pulling with paws and teeth rather than with paws alone or any other such modification as might have occurred in Experiment A The condition prevailing for the rat when placed in the pulling-box at the beginning of Experiment A was precisely what it had been upon scores of times when he had been placed there before In other words, the situation was the pulling-box situation, the rat was hungry and the behavior which ensued was "pulling-box behavior "

In Experiment B the alteration of behavior is the entire question and this, namely, whether the familiar activity of taking hold of the string, pulling in the seeds, and eating them is to occur or whether the string is to be ignored, is the crucial test To employ the terminology of our former report, *Situation I* is the pulling-box with a hungry, trained rat in it. *Behavior I* is the activity of pulling in and eating seeds When, however, the rat has been satiated with food and placed in the pulling-box, *this is no longer Situation I* For this reason Behavior I is correspondingly no longer the appropriate behavior for the rat to adopt when placed in the pulling-box. This is, of course, the experimenter speaking, not the rat Upon his first experience of this sort (cf. left side of Table 2) the rat cannot, it would seem, do other than make some gesture toward complying with the dynamic lines of force which the pulling-box exerts upon him—for both groups the pulling-box is still to greater or less extent a kind of "Situation I" and evidence of this fact is apparent in their having pulled and eaten when first subjected to the conditions of Experiment B Nevertheless, even on the first occasion this quasi-Situation I obtains for some rats more than for others—and distinctly more, on an average, for the operated than for the normal animals

What this condition throws into particularly clear light is the fact that neither box nor string nor seeds nor just any rat constitutes

Situation I. It is only when all these physical appurtenances are simultaneously present and a mobile, propulsive force is expressing itself (i.e., the animal), that we can speak of Situation I and, concurrently, of Behavior I. The experiment reported earlier (2) had to do with a physical set-up and the dynamic unity of the same as established by the animal's activity in that physical environment In that case, however, the disruption of Behavior I (discovery by the rat that Situation I no longer prevailed) was occasioned by a change in part of the apparatus exterior to the animal (food was omitted from the familiar food box) In the present case the apparatus has been left unchanged and, instead, a modification introduced in another phase or aspect of Situation I, viz, the animal's hunger has been removed *It is significant that the objectively observable behavior results are essentially the same in both cases.*

Summarizing again, we may say that behavior constancy is a term applicable only to behavior units functioning as relatively undifferentiated wholes. If a pathway is obstructed and yet the organism continues to strive toward the goal he is seeking, his activity should be characterized as "persistent" That is to say, the behavior is persistent if it exhibits a certain continuity relative to the goal together with docility (4, Chap I, No 8 *et seq*) as regards the means adopted *to attain that goal. The behavior is "constant" if its continuity lies* within its own precincts such that as a *unit* it tends to maintain itself and to run its course A high degree of behavior constancy is one in which the unit's self-maintenance becomes one of blind mechanical repetitions regardless of environmental conditions With the word *persistence* one may characterize cases such as those reported in Experiment A where the drive or urge maintained a relatively unceasing display of activity. When the term *constancy* is used to describe behavior, this will be most appropriate for those cases in which the organism performs a series of acts more or less in disregard of environmental circumstances

In the repetition of Experiment B it was found that operated rats were nearly as much determined by the pulling-box situation in this latter as they had been upon the former occasion Normal rats, on the contrary, display a virtually complete release from the dictates of the pulling-box The manner in which an observer can see that Situation I has disappeared for the normal rats is that Behavior II (ignoring the string) supplants Behavior I. It is apparent by the same means that operated rats were by no means so nearly freed from

the dynamic demands imposed upon them by the pulling-box The behavior unit of operated animals continued to go off despite the fact that they were not hungry.

4 There are undoubtedly circumstances in which a relatively high degree of behavior constancy may prove advantageous, nevertheless, it would appear that the number of cases in which persistence is of particular service to the organism is greater than those in which behavior constancy enjoys this characteristic. In general, it appears that behavior constancy is probably more likely to bring the organism into unnecessary conflicts with his environment than is persistence. It would seem also that where a fixed behavior pattern pursues its self-identical course, mechanically and inflexibly repeating itself, the possibility of learning is proportionally reduced.

VI Summary and Conclusions

For the purpose of investigating the phenomena of persistence and behavior constancy the behaviors of two groups of rats, 5 operated and 6 normal, were observed The apparatus was a device whereby the rats were permitted to pull in string to secure food. Under conditions of no reward the normal animals were found to persist longer and to pull more string than did operated rats Under conditions of being satiated with food and then placed in the pulling-box where food was to be had by the familiar method, the operated rats proved more ready to pull in and eat the food than did the normal rats.

On the basis of a discussion wherein these results are compared, it is concluded that the phenomenon of persistence has to do with efforts to gratify a *desire* or *drive,* whereas behavior constancy refers to a crystallized sequence of *behavior* acts functioning as a unitary pattern.

References

1. Adams, D K. The inference of mind *Psychol Rev*, 1928, **35**, 235-252.
2 Hamilton, J A., & Ellis, W D. Behavior constancy in rats *J Genet Psychol*, 1933, **42**, 120-139
3. Katz, D Sammelreferat uber Hunger und Appetit *Ber u d XII Kong d. dtsch. Gesellsch f. Psychol.*, 1931
4. Tolman, E C. Purposive behavior in animals and men New York. Century, 1932 Pp xiv+463

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LA PERSISTANCE ET LA CONSTANCE DU COMPORTEMENT

(Résumé)

Dans un rapport antérieur on a suggéré que la *"constance du comportement"* est montrée par la continuation d'une forme de comportement malgré des changements de milieu de telle nature qu'on s'attendrait à un comportement modifié Pour étudier la relation entre la *"constance du comportement"* et la persistance, on a comparé le comportement d'un groupe de rats normaux à celui d'un groupe de rats, dont on avait détruit des portions de l'écorce On a mis les animaux dans une boîte et les a entraînés à tirer une ficelle à laquelle on a attaché des semences de tournesol Quand ils ont appris à fond cette situation, on les a mis dans la boîte, mais on n'a pas attache de nourriture à la ficelle. On a constaté que les rats normaux ont tiré beaucoup plus de ficelle dans une plus grande période de temps que les rats opérés

Après cette expérience on a repris l'entraînement normal. Une seconde expérience a consisté à rassasier les animaux et à les mettre dans la boîte, des semences de tournesol étant attachees à la ficelle comme d'ordinaire Dans cette situation, les rats opérés ont tiré et mangé plus de nourriture que les rats normaux

On a suggéré qu'on pourrait à juste titre se servir du terme *persistance* pour le comportement observé dans la première expérience critique, tandis que la *constance du comportement* serait plus caractéristique de la seconde. La persistance concerne les efforts de satisfaire un désir ou impulsion, tandis que la *constance du comportement* a rapport à une suite cristallisée d'actes de comportement.

HAMILTON ET ELLIS

BEHARRUNG UND VERHALTUNGSKONSTANZ

(Referat)

In einem fruheren Bericht wurde darauf hingewiesen, dass die Fortsetzung einer Tatigkeitsgestalt (behavior pattern) trotz Veranderungen in der Umgebung solcher Art, dass eine modifizierte Tätigkeit passender sein wurde, Beweis von "Verhaltungskonstanz" darstellt Um den Zusammenhang zwischen "Verhaltungskonstanz" und "Beharrung" zu untersuchen, wurde die Tatigkeit einer Gruppe normaler Ratten mit der einer Gruppe von Ratten verglichen, bei denen Teile der Hirnrinde zerstört worden waren Die Tiere wurden in einen Kasten gestellt, und darauf dressiert an einer Schnur zu ziehen, an der Sonnenblumensamen festgebunden waren Nachdem ihnen diese Situation völlig bekannt war, wurden sie in den Kasten gestellt, ohne dass das Futter an die Schnur angebunden wurde. Es zeigte sich, dass normale Ratten die Schnur viel langer zu sich zogen, als die operierten Tiere

Nach diesem Experiment wurde die normale Dressur fortgesetzt Ein zweites kritische Experiment bestand darin, dass man die Tiere mit Nahrung sattigte und sie dann in den Ziehkasten stelle, in dem wie gewohlich Sonnenblumensamen an der Schnur befestigt waren Unter diesen Umstanden zogen die operierten Ratten mehr Futter heran und assen mehr, als die normalen Ratten.

Es wird darauf hingewiesen, dass der Ausdruck "Beharrung" vielleicht

passender Weise auf die Tatigkeit angewendet werden konnte, die in dem ersten kritischen Experiment beobachtet wurde, wahrend "Verhaltungskonstanz" fur die zweite Art der Tatigkeit der richtigere Ausdruck sei. Die Beharrung hat mit Bemuhungen, einen Wunsch oder einen Trieb zu befriedigen, zu tun, wahrend Verhaltungskonstanz sich auf eine kristallisierte Reihenfolge von Tatigkeiten bezieht

HAMILTON UND ELLIS

DIRECTION ORIENTATION IN CHILDREN*[1]

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Investigations related to the present problem have been largely concerned with the matter of disorientation. The great majority of these studies have been carried on in the field of animal behavior, more especially with the insects Rabaud (11), in a recent review of the literature on *How Animals Find Their Way About,* remarks that a complete bibliography on the subject would comprise a veritable volume (p. 135). In this summary we find that the problem of animal orientation has engaged the attention of such investigators as Romanes, Loeb, Lloyd Morgan, Yerkes, Claparède, Piéron, Bethe, Watson, Lashley, and many others prominent in the field of comparative psychology

Binet (2) refers to a letter published in *Nature* by Henry Forde in 1873 as the earliest reference to the question of orientation in humans. This letter relates to a communication of Forde with Darwin regarding disorientation of certain experienced hunters in the wild parts of West Virginia. It appears that Wallace and Darwin drew no conclusions in respect to this phenomenon because of insufficient data In 1882 Viguier (13, quoted by Binet, 2, p. 338) published a theoretical discussion of direction orientation in humans and animals, setting forth the view that they orientate by means of a sense of direction comparable to that of taste and smell or other sensory experiences Quite recently W H Hudson (7) and Friedrich von Lucannas (8) have defended Viguier's position, declaring that man has an instinctive sense of direction for the cardinal points of the compass. The experimental studies of "homing" by Watson and Lashley (15) did little to solve the question as to presence of an innate sense of direction in animals They admit that they leave the question in the air. Rabaud concludes that a careful examination of the literature lends no support to the existence

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[1]The writer is greatly indebted to Dr. Joseph Peterson for suggestions and criticisms in connection with the present study.

of a "special" or "innate" sense of direction. He says, "Whether one invisages a mollusk, an insect, a mammal, or man himself, one really percieves no essential difference among them in this respect Orientation in vertebrates and invertebrates is wholly by means of sensory cues" (p. 127)

It appears that Binet (2), Townbridge (12), and Peterson (9) have published the only systematic investigations relating to the problem of *direction orientation in humans* Binet and Peterson have been mainly concerned with illusions of orientation, while Townbridge has studied the methods and accuracy of orientation and a possible relation of these to imaginary maps It is pointed out by Binet that the disoriented person has no sense of direction at all, but, upon coming in contact with a familiar point of reference, he is immediately re-oriented, while the inexactly oriented person meets a point of reference but finds it contrary to his earlier experience· the false system persists, however, even though he knows it to be false. Peterson supplements the findings of Binet with similar illustrations and suggests explanations for the phenomena based upon *well-established principles of social psychology He points out that* the development and maintenance of the sense of direction is somewhat comparable to the development and continuity of personality Both are dependent upon a multiplicity of factors all of which tend in either case to build up and preserve a practically permanent and comprehensive attitude

Townbridge insists that direction orientation is built up by two fundamental methods The first is what he calls the *ego-centric* method, because it is based on the intersection at the ego of lines going out to the cardinal points of the compass The second method he calls the *domi-centric* This method is employed by living creatures other than civilized man who orientate with reference to an established central place, the "home" The former method requires the individual to image a general situation in the form of a map Several of the subjects used, however, were uncertain as to the existence of imaginary maps during the course of the experiment, or otherwise

The method employed by Townbridge consisted of placing a circular piece of paper (a map) before the blindfolded subject who was required to mark from the center of the map the directions of well-known cities or places Using New York City as this center the the subject was instructed to move his pencil as rapidly as possible

toward one of the four designated places: the North Pole, London, San Francisco, and Panama. Subjects with no "imaginary maps" were tested as to errors in locating the cardinal points of the compass. No reliable differences, however, were found between the errors made by the two types of subjects. Furthermore, it is admitted by Townbridge that his data are too few on which to base any general conclusions.

Angyal (1) has used the Townbridge technique, with slight modifications, in investigating the nature of the association (in adults) between visualized places and their position in space. The subjects, without changing their position, were required to draw a plan of how to go from one part of a town (Turin) to another, to indicate the direction of various public buildings, and other similar tasks It was found that the subjects could be divided into two groups with respect to their methods of orientation The first group oriented from their present position—a procedure somewhat similar to the Townbridge domi-centric system The second group drew parallel streets in the same direction on different plans as if they were placed on a definite system of coordinates. This procedure Angyal describes as a "far-near-left-right" system—a very close approximation of the Townbridge ego-centric system. Strangely enough, these methods appear as "natural" to the subjects employing them, even though they were unable to account for such procedure.

In 1908 Warren (14) called attention to the possibility of a magnetic sense of direction in children. The suggestion was made after several unsuccessful attempts in trying to disorientate a 5-year-old child. We are informed, however, by DeSilva (3) that this person (Warren's subject) at the age of 27 (22 years later) possessed only average orientation ability. In the same connection DeSilva describes a case of a 12-year-old boy possessing an automatic directional orientation. It was discovered that this remarkable ability was dependent on correct initial visual orientation, which was then maintained indefintely without conscious attention. The history of this case sheds some light on the development of such an accurate sense of direction. The boy's mother, being left-handed, found it more convenient to substitute the cardinal compass points for the more usual right and left in instructions given the child For example, while very young the boy would be given such orders as: "Get me the brush on the *north* side of the dresser; go sit in the chair on the *east* side of the porch, etc" It is very likely that susceptibility

to disorientation develops under similar situations. De Silva's subject was found to be very easily disoriented when rotated a few times in a dark room. Apparently Warren did not resort to this procedure in trying to disorient his subject.

In his discussion of local signs and orientation tendencies Peterson (10) places much emphasis upon the functional development of the ability to respond accurately to spacial relations Just as the child *learns to locate and respond accurately to stimuli on different parts* of the body, he learns to react similarly to objects and direction of objects in his more remote environment. In both types of behavior the accuracy of response depends upon facility of movement and the frequency with which the stimulus is encountered.

Warren (14) emphasizes the importance of securing additional data relative to the present problem. He says, "So far as I know there has been no scientific investigation of the possible presence of a sense of north-south direction in man . . The problem is offered to those interested in child study as a matter worthy of investigation. If such a sense has been developed in the phylogenetic scale (as suggested by the migration of birds) it may still appear in a rudimentary form in man, and distinct traces may be discovered in childhood which are lost later on in life" (p 377)

The subject at hand is largely an open field Peterson insists that the establishment of orientation systems to the cardinal points of the compass is a subject that has not received the attention that even its practical bearings justify. It appears that no one has yet investigated the development or the accuracy of direction orientation in children. This is the specific problem to which we have addressed ourselves in the present study, which is to be regarded as only preliminary, even though our results will probably be supported by further researches.

Technique

For accurate measurement of direction orientation an instrument was desirable which would not only accurately control the time for the response but also the direction (clockwise or counterclockwise) and extent (in degrees) of the errors It was further necessary that the apparatus be so constructed that it would not interfere with the subject's general accuracy of orientation This latter phase of the procedure presented a problem of considerable difficulty. But the difficulty encountered in securing subjects from the kinder-

garten and elementary grades prevented the use of accurate chronoscopic measurements otherwise obtainable in the laboratory It was thought best, therefore, to record the response time with a stop-watch This method proved to be fairly accurate since very few of the responses (even of the adults) were completed within less than 1 second

The instrument finally constructed for the orientation measurements was essentially a compass dial, and was so calibrated. It was 6 inches in diameter and was mounted on a thin board 15 inches square On this board was placed a smooth tin surface with a small indenture in the exact center of the circle (dial) as a place where the stylus would be moved from at the beginning of each response (trial). When the subject had moved the stylus 3 inches in any given direction it would be stopped by a rim ¼ inch thick

The subject was seated blindfolded in a comfortable position by a table facing due north The dial with the cardinal points in their proper positions was then placed on the table directly in front of him At no time during the experiment was he permitted to see the dial, and other possible precautions were taken to prevent the subject from becoming oriented with respect to the instrument rather than to the points of direction He was given no information concerning his errors The experimenter read to him the following instructions

> "You are now facing north and I wish to see how quickly and accurately you can react to direction signals. I shall call out the several points of direction, as east, northwest, south, northeast, etc, and to each of these words you are to react as quickly as possible by moving the stylus out in the direction called until you reach the edge of the circle (The procedure was now demonstrated to the subject) You are to keep the stylus against the edge of the circle each trial until I set it back in the center again, when we will be ready for another trial The directions will be called out in random order, so you need not, and should not, try to anticipate me in the direction next to be called Just be ready and act quickly, and be as accurate in the direction of your movement as possible."

Special precautions were taken to be sure that the younger children understood the instructions as well as they could

Eight direction signals were used: N, S, E, W, NE, NW, SE, and SW. These were called out in random order until the subject

had reacted to each direction 5 times, making a total of 40 trials. The random order, or course, followed a pre-arranged schedule and was the same for all the subjects A record was kept of the degree and direction (clockwise or counterclockwise) of the error and the time in tenths of a second of each response. The time included the period intervening from the giving of the stimulus word until the stylus reached the edge of the circle. Introspective reports were obtained from many of the subjects at the close of the test as to the difficulties encountered and how they were overcome The subject was also questioned as to his susceptibility to disorientation Such data, of course, could not be obtained from the younger children

The tests were all administered by the writer. About 30 minutes were required for each subject to take the test Nearly all the subjects were obtained from kindergarten and elementary grades of the Peabody Demonstration School and Rosemont Elementary School of Nashville, Tennessee The adult subjects were college students taking work in general and experimental psychology in the Jesup Psychological Laboratory. None of the subjects had had previous training in this particular type of experiment.

Results

In Table 1 we have given time and error averages for each of the 86 individual records The table also gives the age of each subject and the number of incorrect responses made An error of more than two degrees was considered as an incorrect response Due to lack of space complete records of all subjects could not be given, but it was deemed advisable to show at least a partial record of the separate subjects for the sake of illustrating the extent of individual differences, as well as other comparative purposes

The reliability of the procedure was checked by correlating the number of clockwise errors with the number of counterclockwise errors, and again by correlating the average size of the clockwise errors with those counterclockwise The correlation coefficient was obtained by the product-moment method (cf Holzinger, 6, formula 35) and yielded a value of 76 by the former procedure and .83 by the second. Some data on the effects of practice were also obtained The test was repeated (at separate sittings) on 10 subjects selected at randon The records of these 10 subjects showed that practice had no appreciable effect on the number, size, or distribution (direction) of the errors. Some of the older subjects showed practice

TABLE 1

DATA FROM INDIVIDUAL RECORDS SHOWING AGE OF SUBJECTS, NUMBER AND AVERAGE EXTENT OF ERRORS (IN DEGREES), AND THE TIME OF THE RESPONSE (IN SECONDS) FOR THE FORTY TRIALS

Subject	Age in years	Errors No.	Errors Av	Time Av
1	4.0	40	88.7	3.0
2	4.1	40	77.8	3.1
3	4.3	40	86.4	3.5
4	4.3	40	93.6	4.3
5	4.6	40	81.2	3.1
6	4.7	40	95.8	3.8
7	4.7	40	92.1	5.2
8	4.8	40	84.8	3.0
9	5.0	40	88.2	7.0
10	5.2	40	97.6	2.2
11	5.3	40	90.7	3.1
12	5.6	40	92.1	3.3
13	5.6	40	70.2	3.0
14	5.6	40	84.3	3.0
15	5.8	40	88.7	3.0
16	5.8	40	73.5	2.7
17	5.9	40	82.3	2.9
18	5.9	40	81.1	3.2
19	6.1	39	67.5	3.6
20	6.2	40	74.1	2.6
21	6.2	40	82.7	3.0
22	6.4	40	75.2	2.4
23	6.4	40	99.1	2.0
24	6.4	40	71.6	3.2
25	6.7	38	64.2	3.1
26	6.7	40	95.3	5.5
27	6.8	40	65.0	2.8
28	7.0	40	49.7	3.5
29	7.1	39	75.1	2.4
30	7.1	39	74.4	2.8
31	7.1	40	64.2	3.4
32	7.2	40	89.9	1.3
33	7.3	38	62.1	3.5
34	7.3	40	53.6	2.7
35	7.6	40	90.5	3.3
36	7.8	39	47.8	3.4
37	7.8	40	31.2	2.2
38	7.8	40	55.4	3.2
39	8.1	33	13.5	4.0
40	8.2	40	45.9	1.7
41	8.2	36	8.7	1.7
42	8.2	40	34.6	1.8
43	8.4	25	12.6	3.7
44	8.4	37	51.1	3.5
45	8.6	40	27.2	2.4
46	8.8	30	8.8	4.0
47	8.8	35	29.0	1.6
48	8.9	40	22.3	2.7
49	8.9	39	31.2	2.1
50	8.9	40	17.3	2.5
51	9.2	30	8.4	1.5
52	9.3	35	6.9	1.7
53	9.3	40	27.6	3.1
54	9.5	36	14.2	2.5
55	9.5	39	36.6	2.8
56	9.5	40	12.3	2.1
57	9.6	37	9.1	2.2
58	9.6	38	18.7	2.1
59	9.8	37	8.4	1.5
60	9.8	36	13.5	1.9
61	10.0	38	14.3	1.2
62	10.2	35	9.6	1.3
63	10.3	32	8.8	1.0
64	10.3	39	16.2	2.7
65	10.3	40	12.1	2.0
66	10.8	35	12.2	0.7
67	10.9	28	6.0	1.9
68	10.9	32	9.2	1.6
69	11.3	36	10.8	1.7
70	11.3	31	7.7	1.2
71	11.5	38	9.5	1.4
72	11.5	30	8.6	1.5
73	11.6	30	5.6	1.0
74	11.6	33	9.1	1.4
75	11.9	37	7.2	1.5
76	11.9	35	6.4	1.1
77	23.8	31	8.6	1.2
78	25.6	37	8.2	1.7
79	30.0	35	8.2	1.5
80	31.4	31	7.5	1.1
81	32.5	32	7.1	1.0
82	32.6	29	6.3	1.5
83	34.2	27	5.6	1.1
84	34.7	26	7.4	1.1
85	36.1	30	9.7	1.3
86	36.8	36	8.3	1.2

TABLE 2

TIME AND ERROR AVERAGES FOR SUBJECTS OF THE DIFFERENT AGE GROUPS

Subjects Number	Av. age	Clockwise No	Clockwise Size	Counterclockwise No.	Counterclockwise Size	Total No	Total Size	Time in seconds
8	4.44	20 0	88 35	20 0	86 75	40 0	87 55	3.63
10	5 57	21.8	87 72	18.2	81.37	40 0	84.84	3 34
9	6 43	23 0	81.01	16.6	73 09	39.7	71 19	3.13
11	7 37	19.8	64 63	19 8	60 52	39 5	63 08	2 89
12	8.53	20 7	26 61	15 6	23 25	36 3	25 18	2 69
10	9.51	19 1	15.67	17 7	15 40	36 8	15 57	2 14
8	10 46	15 5	8 40	20.7	13 21	36 1	11 18	1 55
8	11 57	14 4	7.64	19 4	8.27	33 8	8.01	1.35
10	31 77	10 9	6 92	20 5	8.09	31 4	7 69	1 27

*Size indicated in degrees

effects with respect to time, but these usually resulted in an increase in the size of the error Subjects No 81 and 82 (cf Table 1), on repeating the test, gained 3 second in average time, but the size of their errors remained constant

The relation of age to the size of the error and the speed of the response is one of the most significant and interesting aspects of the experiment The correlation between age and time is 70, between age and accuracy is .92. These age-growth correlations were based on the 76 children whose ages were between 4 and 12 years; records of the adult subjects were not included in these calculations.

In Table 2 we have given the averages of the results obtained for the respective age groups. While individual differences were very noticeable in these age groups, the averages show a considerable gain in speed of reaction and decrease in size of errors for the older groups The average size of the counterclockwise errors remains slightly smaller than the clockwise errors until just past the age of ten years From this age on there is an apparent reversal of the situation. Our data are too few, however, to conclude that such errors are constant, though there is a bare possibility of such being the case. Some yet undiscovered environmental factor may be functioning so as to produce such errors Such a situation would be somewhat comparable to that reported by Emerson (4) who found that there was a greater tendency to errors right and left than up and down in the case of children's memory for position (on an easel) of objects after they had received bodily orientation

The curve in Figure 1 represents the average size of the errors as

found in the eighth column of Table 2. It is noticed from the curve that the 4- and 5-year-old children are very poorly oriented to the cardinal points of the compass. We might say that an average error of 90 degrees is 50% better than a guess, 180 degrees being a "pure" guess. The greatest gain occurs during the seventh and eighth years. This period of rapid growth in accuracy of orientation is doubtless paralleled by growth in numerous other mental functions. Significant is the slight difference in the extent of the errors beween the 11-year group and the adults. A similar situation with respect to time is observed in Figure 2 to hold for these two groups. It appears that orientation maturity is reached prior to the age of 12 years. The high correlation of such a mental function with age is highly suggestive of a process of maturation. The relation of this process of growth to mental age was not determined.

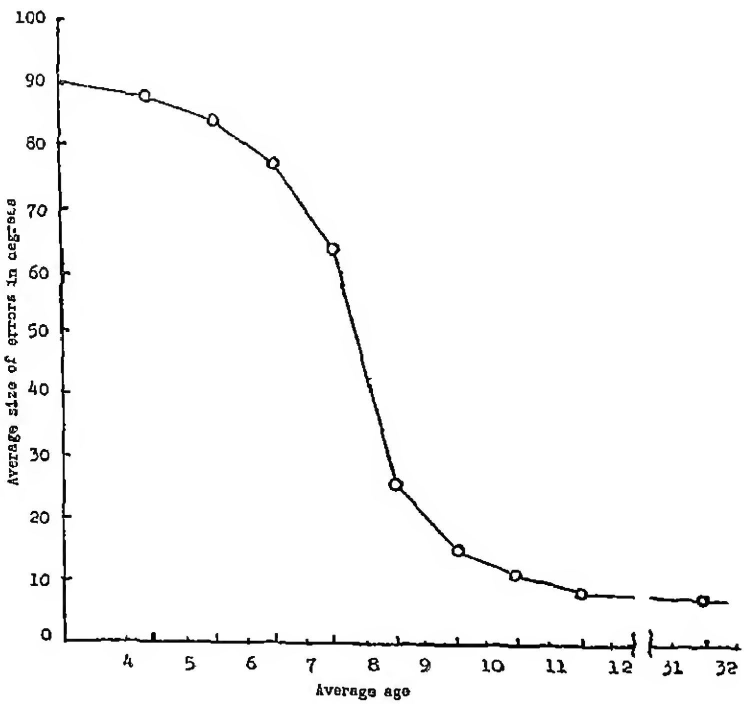

FIGURE 1
AGE GROWTH CURVE IN ACCURACY OF DIRECTION ORIENTATION

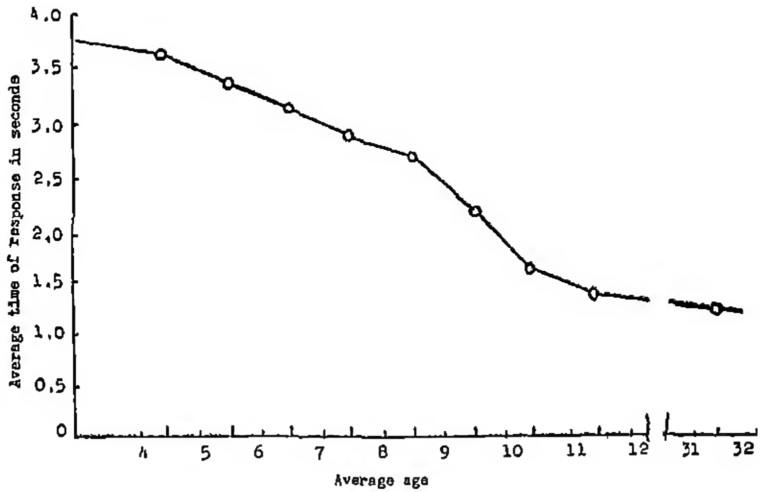

FIGURE 2

Curve Showing Average Decrease in Time of Response for the Different Age Groups

In Figure 2 we have represented data from the ninth column of Table 2. The curve shows the time of the response for the different age groups. It was noticed above that accuracy correlated higher with age than did time. The time curve, however, clearly indicates that there is a close relation between the two factors.

The experiment fails to disclose the slightest degree of evidence in support of a vestigial sense of direction in any of the children tested. Accuracy in this type of behavior is an ability that is learned over a period of years As is pointed out by Freeman (5), the child's notion of the cardinal points of the compass probably begins with reference to some one place Several of the 4- and 5-year-old children reacted verbally to the stimulus "east" by saying, "That's where the sun rises," and to the stimulus "west" as the place where the sun sets, etc. Knowledge of other directions, as above indicated, is no doubt built up in a similar manner Verbal and visual associations are very early formed with these direction points but accurate orientation is a matter of forming and organizing sensory cues into integrated habit systems.

The problem of disorientation was encountered in the case of

several subjects, more frequently with the adults. The writer noticed while giving the tests that some subjects would invariably move the stylus a short distance, or even a complete response, in a direction nearly opposite that of the stimulus Binet had noticed that disorientation was nearly always to the extent of 180 degrees. The writer is extremely susceptible to disorientation, but rarely to the extent of more than 90 degrees. Introspective reports revealed that these subjects were susceptible to disorientation and in some cases were disoriented while taking the test.

Summary

The establishment of orientation systems to the cardinal points of the compass is a subject that as yet has not received scientific investigation. In the present experiment the problem was to study the accuracy with which children of different age groups could respond to direction signals. Seventy-six children, ages 4 to 12 years, and 10 adults with an average age of 31.7 years, were individually asked to give (while blindfolded and facing due north) 40 responses (5 each in shuffled order) to the 8 principal points of direction The procedure consisted in moving a stylus as rapidly as possible from the center of a compass-like dial by means of which size and direction of errors could be recorded. The time of the response was kept with a stop-watch.

The correlation of accuracy with age was 92, time with age was 70 Practice effects were studied by having 10 of the subjects repeat the test and were found to be negligible. The average size of the clockwise and counterclockwise errors was approximately the same, and the correlation between them was .83. The increased accuracy and speed of response with age suggests the possibility of a process of maturation. The tests failed to reveal the slightest trace of a magnetic, automatic, or vestigial sense of direction in any of the subjects tested.

References

2 ANGYAL, A Ueber die Raumlage vorgestellter Örter. *Arch. f d ges. Psychol*, 1930, 78, 47-94

2. BINET, A Reverse illusions of orientation. *Psychol Rev*, 1894, 1, 337-350.

3. DESILVA, H R A case of a boy possessing an automatic directional orientation *Science*, 1931, 73, 393-394

4 EMERSON, L L. The effect of bodily orientation upon the young child's memory for position of objects *Child Develop*, 1931, 2, 125-142.

5 FREEMAN, F N. Psychology of common branches. Boston Houghton Mifflin, 1916 Pp. 275 (see esp Chap. 7)

6 HOLZINGER, K J Statistical methods for students in education. New York Ginn, 1928 Pp 372

7 HUDSON, W. H On the sense of direction. *Century*, 1922, **104**, 688-701

8 LUCANNAS, F On the sense of locality in men and animals *Rev Revs.*, 1924, **70**, 218

9. PETERSON, J. Illusions of orientation *J Phil, Psychol, etc*, 1916, **13**, 225-238.

10. ———— Local signs as orientation tendencies. *Psychol Rev*, 1926, **33**, 218-236

11 RABAUD, E How animals find their way about. New York Harcourt, Brace, 1928 Pp 142

12 TOWNBRIDGE, C C Fundamental methods of orientation and "imaginary maps" *Science*, 1913, **38**, 888-897

13 VIGUIER, C The sense of orientation and its organ in animals and men *Rev Phil.*, 1882, **14**

14 WARREN, H C. 'Magnetic sense' of direction. *Psychol. Bull*, 1908, **5**, 376-377

15 WATSON, J. B, & LASHLEY, K. S Homing and related activities of birds *Carnegie Instit Publ*, 1915, No 211, 1-83

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L'ORIENTATION DE DIRECTION CHEZ LES ENFANTS

(Résumé)

L'établissement de systèmes d'orientation aux points cardinaux est un sujet qu'on n'a pas encore étudié d'une manière scientifique Dans cette expérience-ci le problème a été d'étudier la précision avec laquelle les enfants de divers groupes d'âges ont pu répondre aux signes de direction On a donné individuellement 40 réponses (chacune de 5 en ordre mêlé) aux huit principaux points de direction à 76 enfants, âgés de 4 à 12 ans, et à 10 adultes ayant un âge moyen de 31,7 ans (les yeux bandés et la figure dirigée directement au nord). Le processus s'est composé de faire mouvoir un stylet aussi vite que possible du centre d'un cadran en forme de boussole au moyen duquel on a pu enregistrer la quantité et la direction des erreurs. On a enregistré le temps de la réponse au moyen d'une montre à arrêt.

La corrélation de la précision avec l'âge a été de 0,92, celle du temps avec l'âge, de 0,70. On a étudie les effets de l'exercice en faisant répéter le test par dix des sujets et ces effets se sont montrés négligeables La grandeur moyenne des erreurs dans la direction des aiguilles d'horloge et dans la direction contraire ont été approximativement les mêmes, et la corrélation entre elles ont été de 0,83 La plus grande précision et la plus grande vitesse de la réponse avec l'âge suggère la possibilité d'un processus de maturation Les tests n'ont pas montré la plus petite trace

d'un sens de direction magnétique, automatique, ou vestigiale chez aucun des sujets qui ont subi le test

SMITH

RICHTUNGSORIENTIERUNG BEI KINDERN

(Referat)

Die Bildung von Systemen der Orientierung zu den vier Himmelsgegenden ist ein Gegenstand, der bis jetzt noch nicht wissenschaftlich untersucht worden ist Die Aufgabe des gegenwartigen Versuches war, die Genauigkeit, mit der Kinder aus verschiedenen Altersgruppen auf Richtungssignale (direction signals) reagieren konnen, zu untersuchen. Es hatten 76 Kinder, 4 bis 12 Jahre alt, und 10 Erwachsene, durchschnittlich 31 7 Jahre alt, individuell (mit verbundenen Augen, gerade nordlich gerichtet), 40 Mal auf die 8 Hauptrichtungen zu reagieren, 5 Mal auf jede Richtung, in zufalliger Anordnung Das Verfahren bestand darin, dass man einen Griffel (stylus) so rasch wie moglich aus der Mitte eines kompassartigen Zifferblattes (dial), womit Grosse und Richtung der Fehler registriert werden konnten, bewegte. Der Zeitverwand wurde an einer Sekundenuhr mit Sperrfeder gemessen

Die Korrelation zwischen Genauigkeit und Alter betrug 92, die zwischen Zeitverwand und Alter 70 Die Einwirkungen der Einubung wurden untersucht indem man 10 der Versuchspersonen den Versuch wiederholen liess, und erwiesen sich als ohne Bedeutung. Die mittleren Grossen der Fehler in der Richtung des Uhrzeigers und in der entgegengesetzten Richtung waren annahernd gleich, und die Korrelation zwischen ihnen betrug 83 Die Zunahme an Genauigkeit und an Schnelligkeit der Reaktion mit zunehmendem Alter weist auf die Moglichkeit eines Reifungsvorgangs (maturation process) hin Die Versuche offenbarten nicht die geringste Spur *eines magnetischen, automatischen oder uberbleibenden (vestigial)* Orientierungssinnes (sense of direction) bei irgend einer Versuchsperson

SMITH

A STUDY OF ORIENTATION IN A MAZE*[1]

From the Anthropoid Experiment Station of Yale University, Orange Park, Florida

JOSEPH G YOSHIOKA

INTRODUCTION

Dashiell (1), in his excellent monograph on "Direction Orientation in Maze Running by the White Rat," presented an array of experimental evidence showing that the rat reacts positively to the goal-direction in a maze, and that such direction orientation is independent of the particular stimuli to particular local movements. The writer (3) showed a little later a positive influence of a clockwise goal-direction upon the differential elimination of blinds in the multiple-T maze and also upon the choice of two paths in the triangular maze. The results were essentially in line with Dashiell's finding But in the diamond maze direction orientation was found to be negative Why in this particular case was the result at variance with Dashiell's and mine was discussed in the article and also in another paper (4). Further studies were made since that time with the diamond maze, and the accumulated data were critically analyzed The analysis showed that orientation was positive in a certain situation and negative in another. When it was negative, however, the distribution of the choice scores was far from what would be expected from random choice so that a directional influence was indicated. The present paper substantiates the statement

THE PROBLEM AND PROCEDURE

The nature and implication of the problems of orientation, both experimental and theoretical, were so thoroughly reviewed by Dashiell in his monograph that repetition or minor addition here seems superfluous Let us begin at once with the description of the maze and the experimental procedure The diamond maze (Figure 1) was designed to reveal an influence, if any, of goal-direction upon

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the choice of two alternative paths. It was made of sheet iron Slips, 8 5" wide, were cut to convenient length and shorter slips were bent into desired angles. The straight pieces and angles were combined by wire clips into a diamond shape. Thus the maze could be made and unmade easily A wall, 17 5" square, surrounded by a larger wall, 24" square, made up a diamond pathway, 4" wide. A diagonal path, 4" wide, extended for 12 5" in both directions from two opposing vertices, and ended in a rectangular enclosure, 9.5" x 10", which served as the starting-box as well as the food box The insertion of this path made the outer square 22" long on each side. The maze was placed on linoleum flooring with 4" block patterns which fit in the 4"-wide paths so that a graphic record of running could be made in reference to the block patterns

In Situation I the long axis of the maze was set along the east-west line so that the two paths in the diamond became the north and south paths. The goal was straight ahead of the starting-box so that it was at 0° in reference to the long axis After each trial the goal-direction was reversed by interchanging the food box and starting-box in position. Thus a rat running east in the first trial ran west in the next trial. This reversal had an effect of rotating the maze through 180°. No actual rotation, however, was made, for in one trial one end-box served as the starting-box and in the next trial as the food box The reversal of goal-direction at each trial was introduced to help equalize the frequency with which each path was traversed. A rat that always takes the right path running in one direction will be taking the left path running in the other direction without changing the direction of turning. Thus a stereotyped choice such as exclusive selection of the right- or left-hand path will cause the rat to traverse the north and south paths an equal number of times in the end, and in so doing the frequency that each path has been traversed would not help to fix the position habit On the other hand, another rat that reacts positively to the goal-direction shifted toward the north, as it was done in subsequent situations, will have to make a left turn to go through the north path when running east, but a right turn to go through the same path when running west. Thus for positive orientation the animal is required to make a deliberate choice and variable motor adjustment and positive orientation by a fortuitous coincidence of a particular position habit with the goal-direction was made impossible. The room was illuminated by light coming in from the windows on the north

wall, but due to the high walls of the maze the paths were in shadow No particular control of light seemed necessary since the *winter days in Chicago during the experiment were mostly* cloudy, and differential illumination in the two-choice paths was negligible Sunflower seeds were used for reward to eliminate any possible odorous cue to the goal.

The Results of Experiment I

In Experiment I, 28 albino male rats, 6 months old, were first *trained in the diamond maze set in Situation I During the training,* lasting for 8 days, each rat was daily forced through each path three times in alternation (*rlrlrl* or *lrlrlr*) by blocking the alternative path by a weighted wire screen which permitted the view of the blocked path but barred entrance into it At this stage of training the rats became sufficiently familiar with the maze so that they would rush off from the start to the food box without retracing or hesitation. During the training period each rat went through each path 24 times, 12 times running east, 12 times running west Then the test series began. The rats were given free choice of two open paths six times daily for ten days, 60 choices in all for each rat The goal-direction was reversed at each trial. The result showed that the mean frequency of the choice of the north path was 32.29 ± 1.20 (Table 1) which was not significantly different from the theoretical means of 30 ± 3.87 ($\sigma = \sqrt{npq}$). The north path was not chosen any more than the south path, thus negating an influence of earth magnetism on orientation. Since the goal was at 0° *with respect to the long axis of the maze, that is, running direction,* and both paths were equal in length and pattern, differing only in turns, this negative result was to be expected

Next the same rats were tested in Situation II where the goal was shifted 22.5° toward the north The shifting operation was indicated by the broken lines in Figure 1 To show positive orientation in this situation the rats had to choose the north path and in so *doing had to make a left turn at the choice point when running east* and a right turn when running west The reversal of goal-direction at each trial was equivalent to the rotation of 180° of the maze through the third dimension, that is, through a plane vertical to the floor After the same training in six daily forced runs for eight days a test series of six daily free choices for ten days was given The mean frequency of the choice of the north path was

found to be 32.68 ± 0.88, about the same as that in Situation I. Orientation was not shown as before.

In Situation III, the food box was shifted farther north and stood at 45° with respect to the long axis of the maze. The same rats were tested under the same conditions after the same training. The mean frequency of the choice of the north path was 31.64 ± 1.22. In Situation IV, the food box was placed at 67.5°. Trained and

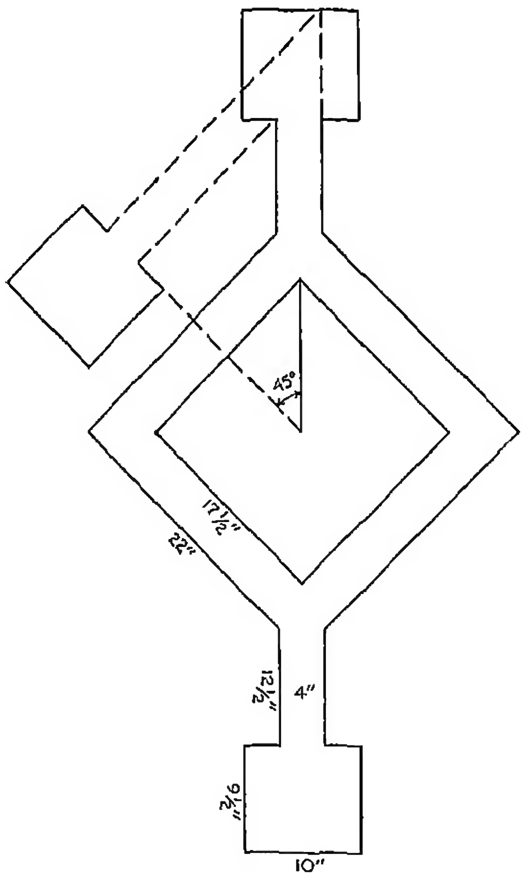

FIGURE 1
DIAMOND MAZE

TABLE 1

THE MEAN CHOICES OF THE NORTH PATH

$N = 28$

Total number of choices = 60

Situation	I	II	III	IV	V	VI	VII
Goal-direction	0°	22.5°	45°	67.5°	90°	90°	0°
Mean choice	32.29 ±1.20	32.68 ±0.88	31.64 ±1.22	31.36 ±1.42	31.04 ±1.44	36.07 ±1.52	26.50 ±2.74
Choice by chance	30.00 ±3.87	30.00 ±3.87	30.00 ±3.87	30.00 ±3.87	30.00 ±3.87	28.15 ±3.75	22.22 ±3.33
Difference	2.29	2.68	1.64	1.36	1.04	7.92	4.28
Critical ratio	0.57	0.68	0.40	0.33	0.25	1.96	0.99
Correlation		.556	.380	.445	.723	—.351	.737

tested similarly, the same rats showed the mean frequency of the choice of the north path of 31.36±1.42. In Situation V where the food box was at 90°, the rats scored 31.04±1.04 for the mean choice. The results are tabulated in Table 1. In none of the five situations was the north path chosen any more than the south path, hence it may be said that the rats failed to show positive orientation to the goal-direction.

In the next situation, i.e., Situation VI, the inner square of the diamond was taken out leaving there an open diamond space, and the food box was placed at 90°. In this new situation the same rats were given six daily free choices for ten days without any preliminary training. In the first trial on the first day all of the rats dashed off from the starting-box along the straight path as they had been accustomed to do, and suddenly stopped at the beginning of the diamond, which was an open space minus the two paths, hesitated, and some even retraced to the entrance. After some time they overcame their timidity and went finally across the diamond space, not diagonally as I expected them to do, but along either the north or south wall as if the paths were still there. Some learned gradually to run diagonally across the space, but most of them skirted along one of the walls. Out of the total of 60 choices for each, the rats scored only four straight runs, on the average. In

the remaining 56 choices the north wall was followed 36.07 ± 1.25 times, *while the choice by chance* was 28.15 ± 3.75. The critical ratio between the obtained and theoretical means was 1.96, sufficiently high to be significant. In the open-space situation the rats showed positive orientation to the goal-direction. For further check the food box was brought back to the 0° position in Situation VII, and the same rats were tested exactly as before. Out of the total of 60 choices, the animals scored 16 straight runs, and in the remaining 44 choices the north wall was followed 26.50 ± 2.74 times, while the choice by chance was 22.22 ± 3.33. The critical ratio between the obtained and theoretical means came down to .99. Here the north wall was followed about as often as the south wall. Hence the differential frequencies in the mean choices of the north wall in Situations VI and VII were the function of the goal position, and indicated positive orientation to goal-direction.

It was thought that the negative orientation in Situations I-V may have been due to the order of presentation of the situations. In Situation I, which was presented first, the rats had to make random choices between the two paths because the goal was at 0° and one path gave no advantage over the other, and this random habit may have been carried over to the subsequent situations. To support this supposition the intercorrelations of the choice scores between the situations were found to be rather low. Between Situation I and Situation II the correlation was .556, that between II and III .380, that between III and IV .445, that between IV and V .723. Only the last shows a fair degree of stability in individual performances. That between V and VI was —.351. This was to be expected since in VI the testing condition changed from two paths to an open space. The correlation between VI and VII was .725, showing fair stability in individual behavior. In the experience of many experimenters who worked with animals in discrimination problems the half-way method of limits starting from subliminal differences and ascending to greater differences has yielded in general similar ambiguous results. When there is nothing discriminable in the beginning, animals tend to form erratic position habits which persist in later situations and spoil discrimination which is made possible by greater differences between stimuli in those situations. To check up on this point Experiment II was carried out.

The Results of Experiment II

In Experiment II, 24 albino and hooded male rats, six months old, were trained and tested under the same conditions as before in the five situations presented in a reverse order. Situation V came first, *Situation I the last, the others in between in order.* The rats faced the goal-directions of 90°, 67.5°, 45°, 22.5°, and 0° in order. The mean frequencies of the choice of the north path in these five situations are given in Table 2. The critical ratios between the obtained and theoretical means in the five situations in order were 13, .67, 27, .08, and 70, respectively. In none of the situations was the north path chosen any more than the south path. Again orientation was negative. Then the same rats were tested in Situation VI where the diamond was an open space and the goal was at 90°. The rats scored *8 straight runs (diagonally across the diamond space) on the* average out of the total of 60 choices. In the remaining 52 choices the north wall was followed 37.83±2.09 times as against the choice by chance of 26.27±3.62. The critical ratio between the obtained and theoretical means was as high as 2.77. Again the rats showed positive orientation in the open-space situation. Next, Situation VII was presented, where the goal was brought back to 0°. They scored 20 straight runs on the average, and in the remaining 40 choices the north wall was followed 32.08±2.95 times, while the choice by chance was 20.46±3.20. The critical ratio between the obtained and theoretical means was 2.67. This result was absurd because here the north path did not orient itself any more than the south path to the goal. The reason for this unexpected result was found in the change of seasons during the experiment. In this part of the experiment winter and spring had passed and summer began sending in strong light daily from the north windows. When the two paths were present *in the diamond, the walls were sufficiently* high to put both paths in a shadow, and the illumination within the paths was not perceptibly different. But in Situations VI and VII, where the diamond was made into an open space, the north wall cast a shadow within the diamond, while the south wall shone brightly by reflected light. Apparently the rats preferred to take the shady path. This explained the result in Situation VII. Was then the positive orientation in Situation VI due to the same spurious factor? To answer this question the same rats were presented with Situation VIII where the goal was at 0° but external light was eliminated

and replaced by an artificial light which illuminated the north and south walls equally. An electric light was suspended from the ceiling *above the center of the maze to ensure such illumination* Under these conditions the rats scored 26 straight runs on the average out of the total of 60 choices. In the remaining 34 choices the north wall was followed $20\ 32 \pm 2\ 95$ times, the choice by chance being $17.21 \pm 2\ 93$ The critical ratio between obtained and theoretical means fell down to .80 The north wall was followed about as often as the south wall, as was expected. Next, the same rats were tested in Situation IX where the goal was at 90° The animals scored 30 straight runs out of 60 choices on the average, and in the remaining 30 choices the north wall was followed 22.36 ± 2.75 times, the choice by chance being $15\ 27 \pm 2\ 76$. The critical ratio between the obtained and theoretical means came up to 1 82 So these rats could react positively to goal-direction, and the positive orientation shown in Situation VI was real, though masked by their negative *reaction to light. In this experiment* the half-way method of limits was applied in the order of greater differences toward threshold, and the rats showed more stable behavior than in Experiment I, as attested by higher intercorrelations of choice scores between situations. The correlation between Situation V and Situation IV was 476 This was the lowest. The same between IV and III was 723, between III and II, 751, between II and I, .751 again The correlation between I and VI was —027 Here the diamond was opened into space. The same between VI and VII was .538; between VII and VIII, .741; between VIII and IX, 953 This method ensures more stable behavior, and has been satisfactorily used in discrimination problems with animals in the past The results in Experiment II confirmed those in Experiment I. Hence it was said that in the two-path situations the rats showed no positive orientation, but in the open-space situations *they demonstrated* definite positive orientation to goal-direction

Discussion of the Results of Experiments I and II

As to the cause of this peculiar manifestation of orientational behavior no adequate explanation can be made at present. Professor Kohler, who witnessed the experiments, suggested, however, that in the two-path situations the goal-direction was so submerged in the maze pattern that it failed to be perceived, but in the open-space situations it emerged into a vividly perceptible figure, and hence was

TABLE 2

THE MEAN CHOICES OF THE NORTH PATH

$N = 24$ (22 in VIII and IX)

Total number of choices = 60

Situation	V	IV	III	II	I	VI	VII	VIII	IX
Goal-direction	90°	67 5°	45°	22 5°	0°	90°	0°	0°	90°
Mean choice	30 54 ±1 38	32 75 ±1 31	31 17 ±2 00	29 63 ±2 19	26.96 ±1 93	37 83 ±2 09	32 08 ±2 95	20 32 ±2 56	22.36 ±2 75
Choice by chance	30 00 ±3 87	30 00 ±3 87	30 00 ±3 87	30 00 ±3 87	30 00 ±3 87	26 27 ±3 62	20 46 ±3 20	17 21 ±2 93	15.27 ±2 76
Difference	54	2 75	1 17	37	3 04	11 56	11 62	3.11	7 09
Critical ratio	13	.67	27	08	70	2 77	2 67	80	1.82
Correlation		476	723	751	751	—027	538	741	.953

reacted to positively To support his view, it was observed that in the two-path situations the rats behaved as if they were reacting to *the diamond figure only, not to* the rest of the path leading into the goal. They seemed to be choosing the paths in reference to the farther end of the diamond where the two paths met. Before this point was reached their running was relatively cautious and deliberate. After passing this point they dashed off to the food box, wherever it happened to be, with little care. In fact, they had nothing more to choose after this point, and seemed to follow the *rest of the path blindly and with great* speed, *which meant to* them simply an excess distance, not much to be bothered about but just to go through Since this point of reference for choice remained the same in Situations I-V, irrespective of the shifting positions of the goal, they chose the two paths 50-50 But when the diamond was made into an open space their behavior changed, they were cautious all the way until the goal was reached. They were hesitant in the beginning of the diamond space, and, after crossing the space, they went along rather slowly as if they were still feeling around the goal-direction. In human perception a reversible figure can be stabilized by striking out or thinning out a few lines here and there. Perhaps something similar may have happened in our maze situations. It has been found over and over again in maze situations that not all the blinds are eliminated with equal readiness and some particular sections or segments are mastered with great difficulty or not at all Therefore, it is conceivable that a maze constructed with a definite physical pattern may offer a somewhat different phenomenal figure to the reacting organisms

The Results of Experiment III

The reversal of running direction in each trial could be thought of as an attempt to establish two contrary habits simultaneously, that is, a left turn when running east and a right turn when running west Such habits can be established in rats, as shown recently by Ross (2) Of course, it is *more difficult for the rat to learn two* contrary habits than to learn a simple habit In order to determine if the rats would show better orientation when the goal-direction was kept constant in all trials, Experiment III was carried out with a new group of rats Thirty albino and hooded male rats, six months old, were tested in Situation I with the running direction from west to east in all the runs The preliminary training was shortened to

four days because by this time they showed as much familiarity with the maze as if they had been trained for eight days by the former procedure. Apparently, constant direction was easier to learn than reversible direction. The test series was the same as before, six daily choices for ten days. It was found that the mean frequency of the choice of the north path, or left path in this experiment, was 27.23±2.57 (Table 3). The critical ratio between the obtained and theoretical means was .60. This was expected since the goal-direction was at 0°. Next, Situation V was given, where the goal was placed at 90° north. The mean frequency of the choice of the north path was 32.37±2.69. The critical ratio between the obtained and theoretical means was .50. Orientation was negative as in Experiments I and II. Next, Situation VI was given, where the diamond was made into an open space and the goal was placed at 90°. Here the rats scored 23 straight runs on the average out of the total of 60 choices. In the remaining 37 choices, 22.50±3.12 were scored for the north wall, while the choice by chance was 18.74±3.06. The critical ratio between the obtained and theoretical means was .86. It was not significantly high but it increased from that in Situation V, indicating at least a tendency for positive orientation. This tendency was more strongly shown when contrasted with the result in Situation VII, which followed. Here the goal was brought back to 0°. The rats scored 40 straight runs out of the total of 60 choices on the average, and in the remaining 20 choices 9.87±3.11 were scored for the north wall, while the choice by chance was 9.80±2.21. The critical ratio between the obtained and theoretical means was as low as .02. The north wall was followed just as often as the south wall. As compared with this result, that of Situation VI showed clear positive orientation.

Discussion of the Results of Experiment III

It seemed that direction orientation had to be learned by the rat by practice, and was not a spontaneous response as instinct theorists might infer. It was shown that the rats showed poor positive orientation in Experiment III where they had practiced in two situations previous to the open-space test. On the other hand, they had practiced in five situations in Experiments I and II before the open-space test was given, and hence they showed more marked positive orientation. It has been mentioned already that the preliminary training period in Experiments I and II, where the goal-direction

TABLE 3
THE MEAN CHOICES OF THE NORTH PATH
$N = 30$
Total number of choices = 60

Situation	I	V	VI	VII
Goal-direction	0°	90°	90°	0°
Mean choice	27 23 ±2 57	32 37 ±2.69	22 50 ±3 12	9 87 ±3 11
Choice by chance	30.00 ±3 87	30 00 ±3 87	18 74 ±3 06	9 80 ±2 21
Difference	2 77	2 37	3.76	0 07
Critical ratio	60	.50	86	02
Correlation		.622	337	.784

was reversed in each trial, had to be twice as long as that given in Experiment III where it remained unchanged in all the runs It has been remarked also that the intercorrelations of the choice scores between successive situations in Experiment I were lower in general than those in Experiment II because in the former the goal varied in direction from 0° to 90° in order in five situations, while in the latter it varied in the reverse order from 90° to 0°. In Experiment III the intercorrelation of scores between Situation I and Situation V was 622, higher than the first intercorrelation in either Experiment I or in Experiment II. The same between V and VI was .337 This low value was expected, since in VI the diamond was an open space while in V it had two paths. Between VI and VII it was 784 Hence constant goal-direction seemed to stabilize individual performances more effectively than variable goal-direction.

"STRAIGHT RUNS"

Another directional response was noted throughout the three experiments in the open-space situations, namely, the straight run diagonally across the diamond space In Situation VI, in Experiment I, where the goal was at 90°, the rats scored 4 straight runs on the average out of 60 choices. In Situation VII, which came next, and where the goal was at 0°, they scored 16 straight runs, on the average, an increase of 12 runs over that in the preceding situa-

tion In Situation VI, in Experiment II, the rats scored 8 straight runs on the average, and in Situation VII, which followed, 20 straight runs, again an increase of 12 runs. The initial straight runs in Experiment II were twice as many as those in Experiment I, although the increase in the runs in the following situation was the same in both experiments It is to be remembered that in Experiment II the goal-direction was presented in a descending order from greater to lesser degrees, and the rats seemed to be learning better to respond to directional cues under this condition. In Situation VI, in Experiment III, the animals scored 23 straight runs, on the average, out of 60 choices, and in Situation VII, which followed, 40 straight runs, showing an increase of 17 runs. Both in the initial scores and in the increase of scores in the following situation, these animals showed superiority over the other two groups in Experiments I and II. The group comparison made in terms of the initial scores of straight runs and of the increase in following situations was quite in accord with that made in terms of the intercorrelations of choice scores between successive situations, and reflected the efficacy of different procedures adopted in each experiment for eliciting orientational responses In general, a fixed goal-direction was easier to learn than variable directions; and directions presented from greater to lesser degrees were likewise easier to learn than those presented in the reverse order Taking all in all, it may be said that direction orientation appeared only after practice and improved with practice

Distributions of Choice Patterns

In the two-path situations, orientation was negative as judged from the mean frequencies of the choice of one path In Situations I-V the north path was chosen no more than the south path, on the average Then were the two paths chosen at random? If so, the distribution of daily sets of scores for the north and south paths should conform to permutational distribution of two variables in six settings Here the case was analogous to tossing a coin six times for one set and getting ten sets in all, and noting the distribution of heads and tails. Such a table of permutation for one and 300 sets was given in the writer's previous paper (5) According to this table, six heads or six tails in one set occur once in 64 sets, the regular alternation, that is, *hththt* or *ththth*, occurs likewise once in 64 sets, other patterns have different probabilities of their own For

TABLE 4
REGULAR ALTERNATION PATTERN IN DAILY CHOICE SCORES

Situation	I	II	III	IV	V
Experiment I (280)*	14	9	13	13	14
Experiment II (240)	25	27	23	6	12
Experiment III (300)	12				9

*The number in parentheses indicates the total number of sets

the sake of simplicity we shall discuss only the regular alternation pattern This pattern occurs nine times by permutation in the same settings as in Experiment I and III, and eight times in the same settings as in Experiment II. The individual records in these three experiments were re-examined for selection of the regular alternation pattern The distribution of the pattern is given in Table 4

It is seen that the regular alternation pattern appeared more frequently than the frequencies by permutation in all the situations except in Situation II, Experiment I, and in Situation V, Experiment III, where it was equally as frequent as permutation, and in Situation IV, Experiment II, where it was less than permutation. In Experiment I, this pattern appeared about equally frequently in the five situations, but in Experiments II and III, it appeared more frequently than permutation in the situations where the goal-direction was at 0° or less than 45° than in the other situations where the goal-direction was at 90° or more than 45° In other words, the rats alternated regularly more often when the goal-direction was symmetrical or nearly so with respect to the two paths than when it was markedly asymmetrical. It seemed that the symmetrical directional cues oriented the rats to the two paths with equal power so that they tended to alternate regularly in the choice, while the asymmetrical directional cues oriented them more strongly to one path than to the other so that they showed more stereotyped (asymmetrical) than regularly alternative (symmetrical) choices, although such an influence was not strong enough to make them take the first path more predominantly. Similar observations were made in the writer's experiment (5), from which the above table of permutation was quoted. In this experiment, 157 rats were choosing be-

tween two parallel triangular paths equal in length, pattern, and turns There was no apparent reason to prefer one path to the other, and, as was expected, one path was chosen about as often as the other, as far as the mean scores of the group was concerned. Thirty rats out of the total of 157, however, chose the two paths 50-50, while the rest chose one path or the other predominantly, though the mean scores for the two paths by this group of 127 were practically the same, that is, no preference was shown for either of the paths as a group. The first group of selected 30 were making 50-50 (symmetrical) choices between the two paths, and scored 11 regular alternation patterns as against 9 such patterns allowed by permutation The second group of 127 were making preferential (asymmetrical) choices for one path or the other between the two paths, and scored 14 regular alternation patterns as against 40 expected by permutation. The distribution of other choice patterns distinguished also a group that was making symmetrical responses from another that was making asymmetrical responses when the two groups were undistinguishable by mean scores. Hence it was said that our rats showed some positive orientation in the two-path situations when evaluated by the distributions of regularly alternating choice patterns, though such orientation was absent when evaluated by group means.[2]

Summary and Conclusions

Summarizing, one may say that three groups of rats were tested for orientational response in a diamond maze where the goal could be placed at 0° with respect to the long axis (running direction) of the maze, and shifted from 0° to 90° by steps of 22 5° In terms of the mean scores of choice between two alternative paths, the rats failed to show positive orientation to the goal-direction, but in terms of the frequency of regular alternation of choice between the two paths, some positive orientation was demonstrated When the two paths were cleared into an open diamond space, the rats showed decidedly positive orientation to the goal-direction by choosing predominantly to run along a wall closer to the goal

References

1 Dashiell, J F Direction orientation in maze running by the white rat *Comp Psychol Monog*, 1930, 7, No 32 Pp 72

[2]A more detailed study of the distribution of different choice patterns for group differentiation will appear shortly in another article

2. Ross, E L The establishment by rats of two contrary discrimination habits *Univ Calif. Publ Psychol*, 1931, 4, 335-345

3 Yoshioka, J. G. Direction as a factor in maze solution in rats *J. Genet Psychol*, 1930, 38, 307-320

4 ———— A further note on a position habit in rats *J Comp Psychol.*, 1930, 10, 309-315.

5. ———— An alternation habit in rats in a simple maze *J. Genet Psychol.*, 1929, 36, 257-265

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UNE ÉTUDE DE L'ORIENTATION DANS UN LABYRINTHE

(Résumé)

On a testé vingt-huit rats pour la réponse de l'orientation à la direction du stimulant dans un labyrinthe en forme de diamant où l'on a pu changer la position du stimulant de 0° à 90° à l'égard du long axe (direction du parcours) du labyrinthe le long de la ligne est-ouest Le diamant a eu deux chemins, celui du nord et celui du sud, et puisqu'on a changé la position du stimulant vers le nord, le chemin du nord a orienté les animaux vers le stimulant. On a constaté que les rats n'ont choisi le chemin du nord plus que celui du sud dans aucune des cinq situations où l'on a placé le stimulant à 0°, 22,5°, 45°, 67,5°, et 90° au nord *L'orientation a été donc négative* Quand on a changé le diamant en espace libre de même forme, les rats ont montré une orientation positive à la direction du stimulant en longeant le mur du nord plus que celui du sud Deux autres groupes de rats, l'un de 24 et l'autre de 30, testés de la même manière n'ont montré aucune orientation dans les situations à deux chemins mais ont montré une orientation positive dans les situations à espace libre Dans les situations à deux chemins, cependant, la distribution des choix entre les deux chemins n'a pas été tout à fait au hasard, bien que les choix moyens de l'un aient été environ les mêmes que ceux de l'autre Les choix réguliers d'alternation se sont montrés plus fréquemment que l'on attendrait selon *la probabilité de permutation quand le stimulant a été à 0°*, mais à peu près aussi souvent que l'on attendrait selon la permutation quand le stimulant a été à plus de 45° *Cet résultat indique quelque réponse d'orientation même* dans les situations à deux chemins.

On conclut que le rat n'a montré aucune orientation dans les situations à deux chemins dans un labyrinthe en forme de diamant comme evaluée en termes des résultats moyens ou choix entre les deux chemins, mais que quelque réponse d'orientation a été presente quand évaluée en termes de la distribution de choix réguliers d'alternation. Dans les situations a espace libre le rat a montré décidément une orientation positive à la direction du stimulant

Yoshioka

EINE UNTERSUCHUNG DER ORIENTIERUNG IN EINEM LABYRINTH

(Referat)

Es wurden 28 Ratten in Bezug auf ihre Orientierungsreaktion (orientational response) auf Zielrichtung (goal direction) geprüft, in einem Diamantformigen Labyrinth (diamond labyrinth) worin die Stellung des Zieles (goal) von 0° bis 90° verschoben werden konnte mit Bezug auf die lange Achse (Laufbahn) (running direction) des der ost-westlichen Linie entlang gelegenen Labyrinthes Der Diamant hatte zwei Pfade, einen nordlichen Pfad und einen sudlichen, und da das Ziel nach Norden verschoben wurde, orientierte der nordliche Pfad die Tiere dem Ziele zu Man fand, dass die Ratten in keiner der 5 Situationen, worin das Ziel bei 0°, 22 5°, 45° , 67 5°, und 90 nordliche gelegt wurde, den nordlichen Pfad ofter als den sudlichen wahlten Die Orientierung war also negativ Wurde der Diamant in einen offenen diamantformigen Raum erweitert (cleared), erwiesen die Ratten eine positive Orientierung der Zielrichtung (goal direction) gegenuber, indem sie mehr an den nordlichen als an den sudlichen Rand angrenzten Zwei andere Gruppen, von 24 und 30 Ratten, auf ahnliche Weise gepruft, erwiesen in den zwei-pfadigen Situationen keine Orientierung, offenbarten aber in den frei-raumigen Situationen *positive Orientierung In den zwei-pfadigen Situationen war die Verteilung* der Wahlen zwischen den zwei Pfaden nicht ganz durch Zufall bestimmt, obwohl die Durchschnittszahlen (mean scores) fur den einen Pfad ungefahr die selben waren wie fur den anderen Die Wahle der regelmassigen Alternierung (Abwechslung) (regular alternation choices) erschienen ofter, als sie der Permutationswahrscheinlichkeit (permutational probability) nach zu erwarten waren wenn das Ziel bei 0° stand, aber ungefahr so oft wie sie der Permutation nach zu erwarten waren wenn das Ziel bei mehr als 45° stand Dieser Befund wies auf einen gewissen Grand der Orientierungsreaktion (orientational response) auch in den zwei-pfadigen Situationen hin

Man schliesst aus diesen Versuchen, dass die Ratte in den zwei-pfadigen Situationen in einem diamantformigen Labyrinth keine Orientierung, als Durchschnittszahlen fur die Wahlen zwischen den zwei Pfaden ausgedruckt, erwies, dass aber die Orientierungsreaktion bis zu einem gewissen Grade gegenwartig war, wenn man diese Orientierung an der Verteilung der regelmassig abwechselnden Wahlen bewertete In den frei-raumigen Situationen offenbarten die Ratten entschieden positive Orientierung nach Zielrichtung.

YOSHIOKA

A METHOD OF STUDYING THE CHARACTER TRAITS OF THE PRESCHOOL CHILD*[1]

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MORDECAI ETZIONY

INTRODUCTION

Since Watson's (13, 14, 15) most valuable experimentations the genetic psychology of emotions has made considerable strides, although our knowledge of the development of the emotions and their intrinsic nature as a total, overt stimulus-response behavior pattern is still very meager. The reasons for this tardy advance are obvious First, while the introspective method in the case of the adult may prove at least somehow suggestive, it is absolutely impossible, and hence fruitless, in child psychology Not much better is the position when we turn to the method of extrospection, on account of the phenomenal and fleeting nature of emotional experiences, they come and go in meteoric fashion. Neither may we be very much encouraged when we endeavor to apply the experimental method It is comparatively easy to perform experiments such as those Watson made on infants. The subjects, as well as the stimuli and responses in this case, are so simple to handle that we may hope in the nearest future to tap off with absolute certainty the first emotions to appear in man But, as we approach the preschool period, between the ages of two and five, we are at loss again. It is obvious that the methods of Watson and the like are here entirely inapplicable. Nor can we find any other ways of carrying on experiments pertaining to the emotions of preschool children. Moreover, even were there such, a serious question may

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[1]This article is based on the nursery-school observations included in the M A thesis entitled, "The Problem of Emotions," that the writer submitted at the McGill University in 1931 An expression of indebtedness and gratitude is due to Dr W D Tait, Head of the Department of Psychology, for permission to visit the nursery-school, and to Dr. C E. Kellogg, Professor in the same Department, for encouragement and valuable suggestions

arise as to whether we may allow ourselves and then be allowed by the parents to excite the subjects—to enrage and infuriate them by various stimuli and situations, to tease them, to incite their jealousy, to call forth their hatred, etc, just for the sake of knowledge. However, there is here one advantage in using infants rather than adults for subjects, namely, while the adult is occupied with his affairs and has no time to render services to science in the capacity of an experimental subject—particularly would he be reluctant as regards his emotional life—the preschool child is, unlike the adult and almost like the infant, in our possession practically all day long, either at home or at the nursery school. Here we can observe the child's behavior at nearly all times, but, while the study of the child's emotional life at home is limited, particularly in its social aspect, it is at the nursery school that the possibilities of observations are greatest. Most studies that have been made on children by biographers and other observers have been so far of general nature *The present writer knows of very few attempts to make a special study of the emotions of the preschool child, particularly in their genetic aspect* Various interesting studies on the emotions of children were indeed made by G. S Gates (4), H E and M C Jones (6, 7, 8), K Lewin (10), L. R Marston (11), M Sherman (12) Highly suggestive is the method of David Katz (9), whereby he attempts to study the development of conscience in the child. The only attempt, however, at an intensive and extensive study of the *genesis* of the emotional life of the preschool child that is known to the writer is that of K M. Bridges (2, 3). Finally, from his observations at the nursery school, it occurred to the present writer that the possibilities for making an extrospective study of the emotional as well as other phases of the child's life are more promising than one would expect. And it was with this object in view that material was gathered to ascertain this conviction.

Nursery-School Observations

The following data were collected at the McGill Nursery School during the period of four months, i e, from November, 1930, till the end of February, 1931. The number of the children observed was 24 (12 boys and 12 girls), their ages ranging between 30 and 58 months. *The method of observation was a simple one, viz*, the writer merely noted as carefully as he could the doings of the

children, without any interference on his part The moment a situation arose provoking an emotional reaction both stimulus and response were taken down with painstaking exactness, verbatim where possible The 66 cases here included are only the representative and main part of the observations collected, and are intended to be only illustrative of what can be done in the nursery school along the line of studying various emotional situations and emotional reactions The material secured by the writer includes cases of ingenuity, intelligence, inventiveness, and ever so many personal traits, but our quoted instances here are limited only to the "coarse" and "mild" emotions, feelings, dispositions, etc., and for safety's sake we shall name them all "character traits"[2]

The reactions were inferred and named on the basis of both the situation as well as the expression of the response. It must be noted, however, that some responses were very difficult to be differentiated and labeled as single and definite reactions, as will be seen in some cases below In fine, the instances here submitted have purposely not been classified or arranged in any way, but are given in the order in which they appeared phenomenally so as to preserve and illustrate the richness and spontaneity of the observed data. The numbers in parentheses indicate the age of the subject, in months.

Data

1. *Reception of a New-Comer* On my first visit the children were looking at me with *wonder* (curiosity) and they seemed to *like* particularly my gray kid gloves, for they all looked at them and some even touched them gently.

Analysis From the above instance one would infer that "*wonder*" precedes the emotional attitude or set, which may be positive or negative, i e., the wonder at the new object (in this case a person) could have developed into fear and dislike as well as into sympathy.

2 *Admiration and Tenderness* Girl N. F (30) took my gloved hands into hers gently and kissed them affectionately—apparently she liked them very much.

[2]The term "character traits" is here preferred to that of "emotions" not only in order to avoid the whole controversy regarding the term "emotion," but also, and mainly, because in our study we purport to include under "character traits" a wider range of experiences than only those which would be warranted under the term "emotion"

Analysis. Was it the *admiration* and *tenderness* for my gloves, for myself, or for both? From N F.'s later attitude towards me I am inclined to think that the gloves, being nice, and my hands being most accessible to her mouth, were the medium through which the "hearty welcome" was extended But it may also be possible that it was the gloves that N F. liked so immensely, then an immediate association was made between the thing owned and the owner, hence I became the "substitute" thereafter.

3 *Superiority versus Inferiority* Girl J. (54), playing on the benches outdoors, says to boy B (41). "I told you not to come here!" (*self-assertion*), the latter goes away insulted answering by making a grimace and showing of tongue (*submission*)

Analysis. The responses speak for themselves.

4 *Appreciation or Jealousy?* Girl H (47), on seeing my gloves and then looking at her own mittens· "Mine are nice too!?" Others say the same. "Nice too!?" All are looking at me with the expectation to hear that it is so

Analysis No doubt there is here a marked element of jealousy, but whether it is pure and only jealousy is hard to say It is possible that a tint of *aesthetic appreciation* may be detected here —the child does not only want to have *the same* gloves as mine, but also wants to see them *as nice* as mine, i.e., it appreciates the "beauty" of my gloves

5 *Pity-Wonder* Boy J C. (30) is hurt and he cries Girl E (30) and boy G. (51) look at him with a marked *pitiful* and *sympathetic* expression on their faces

Analysis This expression seemed to be mixed with *wonder* as if they thought and felt "What makes him cry? . . Wonder what he feels . . . Listen how he cries! It's bad to be hurt, eh? . . . poor G "

6 *Self-Assertion in Play.* Girl J H (54) is taking girl E K. (30) "Come here baby" Then to another child "Let the baby pass!" Mother J H. to Baby E K (with serious air) "You'll sit here all morning! . . . Open your mouth, like that! (shows how) . You'll be the maid, and we (pointing to girl Mj 43) will be the mothers Will you be good? Say 'yes,' and I'll give you candy" Mj picks up a withered leaf and gives it to Baby, "Here is the candy" Baby E K resists being forced to do things as "mothers" tell her and she actually cries. Mothers (with *tenderness* mixed with *scare*) "Sh, sh, sh . . "

Analysis We have here obviously self-assertion fully expressed in play. The tenderness exhibited by the "mothers" is somewhat true, somewhat a make-belief to encourage Baby E K to continue her rôle, and it is also part of the play performance

7 *Love, Jealousy* Girl A (39) would not let boy H take me around, she embraces my feet strongly and her face expresses. "He is only mine, and no one else's"

Analysis *Jealousy* and *rivalry for love* are here evident

8 *Self-Assertion.* I say to boy H (38); "Are you little H ?—" "No, I am a big boy!" (*Self-assertion*) He yields to me all morning and would not let me go (*want of object to love*).

Analysis *Self-assertion* and *want of object to love* are clearly exhibited in the above instance.

9. *Self-Assertion.* Girl H (47) to her "baby" E K (30): "I am big, eh?!" (*self-assertion*).

Analysis. *Self-assertion* exemplified again.

10 *Pugnacity and Anger* Boy G (51) and boy D. (48) fight for a little pail . the same fight also over a bench (*pugnacity* for *possession*); they grab each other by the shoulders and have a clouded countenance (*anger*)

Analysis *Pugnacity* is usually prompted by the want to possess It goes hand in hand with *anger*

11. *Rivalry for Possession and Love.* Girl N. (30) to boy H. (38), both looking at me covetously "He is mine!" (with an expression of determined and decided possession)

Analysis. Here the desire to possess has its source in love, yet both are synonymous and implied in each other.

12 *Pride and Elation.* Girl J H (54) to her friends· "My mother told me she's going to buy me a nice kimona!" (she said it twice this morning with an air of *pride* and *elation*)

Analysis. *Pride* must needs be distinguished from *boasting,* although they are interrelated. J.H not only boasted that she was going to get something, but she also expressed her joy that she would get something nice

13. *Introversion* Girl M.M. (58) is sitting alone and sings to herself. (She is said to like solitary play.)

Analysis Would M.M. be an instance of an *introvert* type?

14. *Affection, Tenderness, and Sympathy.* Girl N (30) does not want Miss M. or anyone to take her off the box, except myself (*affection*)

N. assumes a very pitiful expression on seeing a child fall and tries gently to pick him up (*tenderness* and *sympathy*).

Analysis Both cases illustrate *affection, tenderness,* and *sympathy,* respectively.

15 *Sympathy and Pity* Boy J C (30) shows on his face an expression of distinct *sympathy* for girl N (30), because she cannot get boy H 's (38) car H , moved by N.'s tears, finally gives the car willingly (*pity*)

Analysis Sympathy and pity are inherently the same, but they seem to differ in that the former is a passive state, the latter active, sympathy appears to be less intense than pity

16 *Affection and Affective Jealousy* Girl N. (30) takes around girl E. very tenderly and kisses her (*affection*).

N pushes away girl A. (39) from me and declares· "My 'Tony' " (meaning—Etziony)

Analysis. Affective jealousy implies an exclusive want to possess the object of affection

17. *Ownership* Boy J S (47) pushes away boy Bl (49) from "*his*" engine.

Analysis The case illustrates the sense of ownership which excludes the right of others.

18 *Desire Banishes Logic* Boy B. (49) quarrels with boy S (54) about a sleigh. S.. "I had it first!" B "But I *want* it!" (declaration made determinedly) B grabs the sleigh with force from S 's hand

Analysis S. appeals to B.'s sense of justice, but B. ignores it and explicitly gives reason for that. B. is physically stronger and more quarrelsome, S must consequently give up the sleigh.

19. *Hot Temper.* Boy Bu (39) gets enraged and clenches his fist and teeth.

Analysis Bu 's teacher informs me that Bu quite often gets in a tantrum of *rage*

20 *Love Rivals* The boys D. (48), J C (30), and Bo (41), who sit on the box, are competing in showing kindness to girl E K (30). J.C is getting off his seat and offers it to her saying, "You wanna sit?"

Analysis The content of the above speaks for itself

21 *"Let's Have Fun"* Five children rejoice simply in "bumping" hard while riding on the see-saw they built for that purpose and they scream a "song"

Analysis. It is difficult to know what contributes more to this joy—the organic (sex?) pleasure derived from riding on the see-saw, or the social factor of the play; probably both have their equal share in the "good time."

22 *"Sissy."* Girl N. (30) pushes down violently boy S. (54) from the "jumper" and the latter calls for help. "She pushes me down!"

Analysis Here we have a submissive type of a boy, for, if S. wanted to, he certainly could have overcome girl N. who is not only so much younger than he is, but is in reality a very meek child.

23. *Submission and Suggestion* Girl N. (30) takes me around and pushes away girl E. (30) who approaches me; on my reproach for being unkind, N pats E gently and kisses her.

Analysis. This sudden change in attitude is probably due to N.'s submissive feeling with regard to me and her want to please her object of love (me), but no doubt suggestibility also plays its important rôle.

24 *Jealousy* I pat girl A (42), and girl N (30), on seeing this, pushes her away, exclaiming with anger· "No!" (meaning, no, she isn't your pet!).

Analysis. This is an instance of true *jealousy*

25. *Boasting.* Girl N. shows her friends her "hankie" "See, nice "mouch" (meaning mouchoir; N has a French maid)

Analysis. There is probably here also an element of aesthetic appreciation of the nice object, which is to be distinguished from the "showing off" which is in most cases a pretense rather than a justified attitude.

26 *Love on Suggestion.* N (30) wants to push boy D. (48) off the bench, and I say to her: "D. is a good boy." She then hesitates a moment, pats him, and then embraces him.

Analysis The apology on the part of N is more mechanistic than really *felt* N likes me a great deal and consequently submits to my suggestion.

27 *Showing-off* N. calls me to see how well she can climb on the box: "'see?"

Analysis N. is anxious to show her object of affection (me) what she can accomplish

28 *Desire to Be Noticed.* Girl N. (30) falls and waits for me to pick her up. A moment later she pushes girl E (30), who falls, and then, on my suggestion, N picks her up and kisses her.

Analysis It appears that N. performs these acts in order to draw my attention to herself.

29 *Kindness* Boy B (49) exhibited *kindness* twice this morning

(1) Boy J S. (47): "I want this bench!" B. (magnanimously): "Sure, you can have it!"

(2) Boy S. (54) grabs B's bench, exclaiming. "I want the bench!" B.: "Will you let me have it later?" S.: "Yes" B: "All right! Take it."

Analysis. The case is clear without comment

30 *Pleasure in Fear.* Boy B. (49) is venturesome—he stands on the edge of a bench placed upside-down on the box and jumps off, he does not mind when the bench falls on him and hits him, he rather enjoys the moments of *excited* and *scared* thrill When the bench hits him he momentarily turns pale, blinks with the eyes, and when all is over he catches a long breath of relief and laughs somewhat confusedly

Analysis It is difficult indeed to know which of the components of the excited thrill is more prominent, fear or its following pleasure, but it is certain that both have their share in the experienced thrill.

31 *Kindness* Girl H (47) offers me her postcards "You want one?" I: "No, thank you!" H "You want all of them?"

Analysis The instance is self-explanatory.

32 *Desire for Power.* Boy S (54) and boy D. (48) have a dispute, each of them wanting to be the "mummy" and not the baby.

Analysis This case is equally self-evident

33. *Anger for Fun* Boy J.C. (30) plays alone with his doll; he spanks her angrily and has a clouded face and clenched teeth

Analysis This anger is actually not true, for it is exhibited in play; nevertheless, it may be a case of Freudian transference

34 *Pleasure in Pain.* Girl J H (54) enjoys bumping her head very forcibly against the wooden box.

Analysis The case explains itself.

35 *Sadism* (?) Boy Jn. (49) runs for no apparent reason to three children at hand and hits them, he pinches one of them, clenching his teeth

Analysis That there was no immediate cause for this sadistic outburst, I am certain But I wonder what latent force prompted the subject to behave that way.

36. *Remorse* Boy Jn. (49) grabs girl H.'s (47) toy and throws it over the fence. Miss L. punishes him by taking him "in" and he sits there down-hearted He answers my questions only by nodding of head. I pretend not to know the reason of his being punished, and say to him. "Are you cold? Did you get hurt?" Jn nods negatively, but he does not tell why he is "in" I finally say to him. "Good-bye! 'see you later." He responds by merely nodding affirmatively

Analysis Jn evidently is *ashamed* of his deed and feels conscientious, he does not admit his "crime," but at the same time does not deny it

37 *Showing-off.* Girl N (30) throws down boy D. (48) and then cleans the dirt off his coat.

Analysis. N always dares to hit or tease others when I am around in order to exhibit what she can do. She displays all that in order to draw my attention to her. (Cf. Cases 25-28)

38. *A Furious Fit* Boy B (39) clenches his teeth and shakes his head violently and furiously for no apparent reason

Analysis. It may be that there is a remote latent reason for this outburst, but it may also be that it is a sheer discharge of accumulated nervous energy. (Cf. Case 35.)

39. *Pleasure in Fear.* Girl N (30) and boy B. (39) play "bogy-man" N runs away joyfully from B with an air of fear: She frowns, makes shrinking movements, and shrieks when approached by the "bogy-man." She seems to enjoy her fear for she encourages the "bogy-man" to attack her

Analysis We have here a splendid example of how the expression of an emotion as such may be misleading when not related to its stimulus. (Cf. Case 30.)

40. *Dramatic Ability.* Girl H. (47) says to me, while pointing to boy G (51) who lies very quietly in her little wagon "He is *awfully bad!*" (expressed very *dramatically*).

Analysis From the facial expression of H. and from the dramatic way she pronounced "he is awfully bad," it was certain that she was quite aware of the rôle she had to perform.

41. *Transference of Revenge.* Boy B. (39) has to stay "out" of the playing-room, because he was bad On seeing me go to the outside door, he says to me· "Wher' you going?" I· "Home" He then shouts· "Don't go home!"—"Why?" B : "Because I want

you to stay in the kitchen!" I: "Why?" B "Because I won't let you go!!!" (He shouts forcibly and hits me.)

Analysis. B has no way of taking revenge on his teacher, so he gives outlet to his desire of revenge by transferring it to me and hitting me. Thus an innocent object (me) becomes his meant and intended object of revenge.

42. *"Destructiveness?"* Boy D (48) has nothing to do, so he runs to B (49) and throws over his "castle." He is taken out of the room by the teacher, who tells him, "You cannot play with all the children when you spoil somebody's beautiful castle." To that declaration, D answers with an astounded expression on his face: "Did I?" . . . D. stays now in the passage, and I say to him: "Why are you here? Don't you want to play with the children?" D: "Yes." I. "So why are you here?" D "Because Miss L put me here." I "Why?" D "Because." I: "What do you mean 'because,' for no reason?" D: "Yes, for no reason!"

Analysis. D did not tell a real lie. He, truly enough, knew why he was out, but even the punishment did not convey to him the intended message that he did something wrong. We may draw such an inference from his astounded question, "Did I?" meaning by that, he did not realize he had really destroyed the "castle" by his deed. The pedagogical implication of this instance is too evident to be commented upon.

43. *Friendship.* Girl I. (38) and girl H. (47) express their love for each other with great enthusiasm, they do not leave each other and hold hands tightly, none of the group plays in which they participate can separate them, in the collective play of "musical bumps" it is required to walk singly, the rest of the children comply with the requirements, and only I and H walk together, side by side, holding each other's hands.

Analysis. The girls I and H both have a particular liking for each other not only in this instance, but all the time.

44. *"Blue" Mood.* Girl N. (30) would not play "Little mouse was creeping", she was restless this morning, refusing to do what all others did.

Analysis. That this was a mood and not stubbornness I inferred from the sad and apathetic expression on N.'s face.

45. *Enthusiastic Accomplishment.* Girl I. (38) shows me the "building" she made of blocks. "See this building? Isn't it lovely?

It's high, high, going right up to the sky! . . (in low voice) because baby may fall out."

Analysis. I. enjoys immensely the product of her work. She "built" the "edifice" purposely high so that the baby does not fall down. Our logic and experience dictate to us that the nearer we are to the ground the more secure we are, but, curiously enough, to the subject it is safer to be far away from the ground in order not to fall on it This is indeed a sound syllogism but fallacious and untrue empirically.

46 *Self-Assertion.* Some children of the older group, on seeing the younger children coming down, exclaim mockingly. "Here the babies come!"

Analysis This attachment of significance to being older and want to be no more "a baby" is a prevalent characteristic of all children This is easily explicable, since age is to them synonymous with power.

47 *Sympathy Enacted* Boy H. (38) shows boy J S (47) his dirty hand. J S. sympathizes with his friend and tries to clean it, when his endeavor is in vain, J S thinks for a moment and then says advisably: "You will have to wash it with soap and water"

Analysis. There may be a self-assertive coloring to this sympathetic attitude, and want to help on the part of J.S

48. *"Lover Preferred."* Girl N. (30) is calling to be taken off the box. Miss L wants to do it, but N. would *not* go, insisting distinctly that I take her off.

Analysis The above instance is self-understood.

49. *Self-Assertion.* Boy J.S. (47) approaches me with girl E. (30). J.S. is boasting: "I am bigger than E! I am a big boy, ain't I?" E. looks down submissively

Analysis. Same as 46.

50 *Sympathy.* Boy S. (54) to girl H. (47), pointing at girl E. (30) who stands nearby. "She is a cry baby, isn't she?" H to E, with sympathetic look and expression: "You are not a cry baby, eh E?"

Analysis. H's sympathy has probably its root in self-assertion and awareness of being herself already out of that "miserable stage"

51 *Expression of Anger* Boy J.S (47) yells forcibly and angrily, because *he* wants to put away the benches. He clenches his fists, stamps with his feet, and his face flushes.

Analysis. Anger arises when a desired action is interfered with.

52 *Fury.* J S (47) puts a great number of blocks one on the other in order to build a "house", a few blocks fall down. J S clenches his teeth and fists: "Oh dogs, who did it!!"

Analysis Same as 51. J.S looked around to find what caused the blocks to fall, and when he found no one responsible for it, his fury grew to a higher degree.

53. *Self-Assertion.* Girl A. (39) "spanks" boy G. (51); G to A with warning pride: "Don't hit me, bad girl—I am a boy!"

Analysis. The boy asserts superiority to the girl on the basis of their sex differences It is to be understood that this feeling is mainly acquired from information, but it is also due to past experience.

54. *"Vamping."* Girl N (30) exhibits a loss of her usual interest in me, but I soon find out that it is not meant but she is only teasing me because I do not very often respond to her sympathetic appeals, so she "ignores" me and wants me to know it: She purposely passes near me several times and looks to see whether I notice her, and as soon as I look at her, she turns her head away snobbishly. Very soon, however, she approaches me with tears, as if guilty of something and talks to me She asks me to pick up a stick for her, although she could easily do it herself, since it is within her reach . .

Analysis. The instance explains itself without any comment.

55 *Remorse.* Boy Jn (49) takes away a few blocks from boy J.C. (30) J.C. cries and Jn. looks at him astonished as if he did not expect all that He then takes on an expression of guilt as if regretting the deed and—he leaves the blocks

Analysis The unexpected situation (crying in this case) which arises as a result of the child's deed seems to be, partly at least, responsible for his regret Fear or scare, then, is a constituent of regret

56 *Self-Assertion through Destruction.* Boy D. (48) throws down the blocks of his "castle" and turns to me with pride in his accomplishment: " 'see, knocking down these."

Analysis D. built and destroyed his "castle" with an *a priori* design and purpose thus to exhibit his power

57. *Showing-off Rudely Expressed* Boy J.S. (47) shouts to girl H (47) with power and force. "Let me slide, you dirty old dish!"

Analysis This form of address is certainly not to be ascribed to the ingenuity of J.S., to be sure, he must have heard this expression somewhere.

58. *Jealousy* I greet girl E. (30): "Hello!" Girl M. (43) to me "Say to me 'good morning' too!"

Analysis The instance is too clear to be explained.

59 *We Are Funny When Angry.* Boy B (49) wants three benches for sliding, but he is not allowed to have them, because others, too, want a bench, so he gets into a furious temper, jumping around enraged Boy S (54) thinks B. looks rather funny and laughs at him B then throws himself at S., but his rage passes quickly and two minutes later kindly invites S to play with him

Analysis B changed his attitude towards S. so readily because he himself realized the uselessness of his request Again, it is well known that children generally change their moods more readily than adults

60. *"Musn't-touch-it"* Boy G (51) plays in snow and boy J S (47) comes tramping on it. G immediately flares up for being intruded upon and hits J S. in the face with a spoon.

Analysis. Nothing is apt to make one angry so easily as the interference with his doings

61 *"Come on, Let's Fight"* Boy Jn (49) and boy D (48) fight with boy B (39) for no reason, the fight apparently having been started "just like that." D and Jn. run to me for "shelter." They assume a true expression of fear, although they are not at all afraid of B

Analysis. B is much younger than Jn. and D The older playmates have no reason to be afraid of B. even if the fight were real, yet a true expression of fear is assumed in the game. In this case, too, as in instance 39, we see how sheer behavior may often be misleading if its conditions are unknown.

62 *"Gee, I Like Her."* Boy H. (30) says to me, while pointing at girl E. (30): "Isn't she cute? She wears a nice white sweater Her 'mummy' sewed it for her!" (with enthusiasm)

Analysis. The liking for E is probably associated with the liking for her nice sweater. An element of aesthetic feeling may easily be detected here.

63 *Jealousy* Boy H (30) makes an "airfane" (airplane); girl N (30) makes an "airpane," too. N does not like H 's com-

petition with her ingenuity and shouts furiously "No airpane!" H. naturally contradicts her by answering, "Yes it is!" N. pushes H and throws down all his things

Analysis. Jealousy is displayed on this instance very vividly and intensely.

64 *"I Am Clever, Ain't I?"* Girl E (30) shows me her pegboard, and waits for my praise with an expectant look. She says: "Look I make!"

Analysis. Little E is anxious to know that she, too, although meek and tiny, could accomplish things

65 *"That's Nothing"* Girl I. (30) sits on the toilet and calls to me without any sign of shame: "Do you see me?"

Analysis Shame seems to be a conditioned response, originally derived from fear

66. *"I'm So Sorry"* Miss L. reads a hard-luck story about Half-Chickie Girl H. (47) interrupts her with a pitiful voice and look "Oh, I'm sorry for Half-Chickie"

Analysis It is hard to understand, in this case at least, how even such a form of pity may be claimed to be acquired, for H. heard about Half-Chickie for the first time.

TABLE 1

INDIVIDUAL CHART OF CHARACTER TRAITS AS THEY WERE DISPLAYED BY THE NURSERY-SCHOOL CHILDREN

Age (mos)	Sex	Subject	Character traits	No of traits exhibited
30	Boys	A	Aesthetic appreciation (clothes)—62,* pugnacity—63, rivalry (ingenuity)—63	3
		B	Anger (play)—33, courtesy—20, rivalry (love)—20, sympathy—15	4
	Girls	C	Pity-wonder—5, pride (self-praise)—64, submission—49, sympathy—5	4
		D	Admiration—2, aesthetic appreciation (handkerchief)—25, affection—14, 16, "blue mood"—44, boasting—25, jealousy—16, 24, jealousy (ingenuity)—63, love on suggestion—23, 26, pity-wonder—5, *pleasure-in-fear*—39, *preference for* lover—48, pride—25, pugnacity—63, rivalry (ingenuity)—63, rivalry (love)—11, self-assertion—22, self-assertion (play)—6, showing-off—27, 28, 37, submission—23; sympathy—14, tenderness—2, 14, 16, "vamping" (coquetry)—54, wonder (fear-dislike-sympathy)—1	23

TABLE 1 (*continued*)

Age (mos.)	Sex	Subject	Character traits	No. of traits exhibited
38	Boys:	E	Pity—15, rivalry (love)—11, self-assertion—8, yielding—8	4
	Girls	F.	Friendship—43, self-appreciation—45	2
39	Boys	G	Rage—19	1
		H.	Fury-fit—38, pleasure-in-fear—39, pugnacity (play)—61, transference of revenge—41	4
	Girls	I.	Jealousy—7, rivalry (love)—7	2
41	Boys	J	Submission—3	1
		K	Rivalry (love)—20	1
43	Girls	L	Jealousy—58	1
47	Boys	M	Anger (expressed)—51, anger (higher type)—60, fury—52; jealousy—57, ownership—17, 29; rough showing-off—57 self-assertion—49, sympathy (enacted) —47	8
	Girls.	N	Aesthetic appreciation (gloves) (?)—4, dramatic ability—40, friendship—43, jealousy (?)—4, kindness—31, self-assertion—9, sympathy—50, 66	7
48	Boys	O	Anger—10, desire for power—32, "destructiveness"—42, fear (play)—61, pugnacity—10, pugnacity (play)—61, rivalry (love)—20; self-assertion (through destructiveness)—56	8
49	Boys	P.	Fear (play)—61; fury—59, pugnacity (play)—61; remorse—36, 55, sadism (?) —35	5
		Q	*Kindness—29, pleasure-in-fear—30, pugnacity (desire banishes logic)—18*	3
51	Boys.	R	Anger—10, anger (self-assertion) (?)—51; pity-wonder—5, pugnacity—10; self-assertion—53; sympathy—5	6
54	Boys:	S	Anger—59, desire for power—32, ownership—29, pugnacity (desire banishes logic)—18; ridiculing—50, 59; submission—22	6
	Girls.	T.	Elation—12, pleasure-in-pain—34, pride —12; self-assertion—3, self-assertion (play)—6	5
58	Girls'	U.	"Introversion" (?)—13	1
30-58	Boys and girls.		Group joy—21; wonder (curiosity)—1	
42-58	Boys and girls:		Group self-assertion—46	

*The number following the dash after each character trait refers to the number of the case where that trait was exhibited. Thus, girl D, 30 months old, exhibited "showing-off" three times, the full illustration of which are reported in the Cases 27, 28, and 37

TABLE 2

Group Chart of Character Traits of Nursery-School Children

No	Character trait	Frequency	No of children
1	Admiration	1	1
2	Aesthetic appreciation	3	3
3	Affection	2	1
4	Anger	7	5
5	"Blue Mood"	1	1
6	Boasting	1	1
7	Courtesy	1	1
8	Desire of power	2	2
9	"Destructiveness"	1	1
10	Dramatic ability	1	1
11	Elation	1	1
12	Fear	2	2
13	Friendship	2	2
14	Fury	3	3
15	Introversion (?)	1	1
16	Jealousy	7	5
17	Joy	1	5
18	Kindness	1	1
19	Love (on suggestion)	1	1
20	Ownership	3	2
21	Pity-wonder	4	4
22	Pleasure-in-fear	3	3
23	Pleasure-in-pain	1	1
24	Preference for lover	1	1
25	Pride	3	3
26	Pugnacity	7	6
27	Pugnacity (desire banishes logic)	2	2
28	Rage	1	1
29	Remorse	2	1
30	Ridiculing	2	1
31	Rivalry (ingenuity)	2	2
32	Rivalry (love)	6	6
33	Sadism (?)	1	1
34	Self-appreciation	1	1
35	Self-assertion	10	8
36	Showing-off	3	1
37	Showing-off (rough)	1	1
38	Submission	4	4
39	Sympathy	7	6
40	Tenderness	3	1
41	Transference of revenge	1	1
42	"Vamping" (coquetry)	1	1
43	Wonder (curiosity)	1	Several
44	Wonder (fear-dislike-sympathy)	1	1
45	Yielding	1	1

What Do We Learn from the Above Data and Tables?

The above data and tables throw considerable light on the assertions the writer made—they display a wealth of traits children exhibit at the age of 30 to 58 months Thus, for example, from Table 1 we learn that girl D exhibited at the age of 30 months 23 character traits(1). Girl A., on the other hand, exhibited only three traits Again it will be noticed that only 21 out of the 24 children are reported on This was due not to any selection or choice on the part of the observer, but it simply means that some children presented themselves more than others, while some escaped his notice altogether Also, the gaps in age, say between 30 and 38 months, 43 and 47 months, etc., as well as the omission of ever so many traits of many of the subjects, in spite of their indubitable occurrence at and above the age of 30 months, merely show that the writer had no opportunity to observe them, or that they somehow escaped his notice. Hence it must be evident that this investigation, particularly its method, is only suggestive, illustrative, and explanatory, but by no means conclusive. Again, from Table 2 one sees that the most prominent traits as to the frequency of their occurrence were self-assertion, anger, jealousy, pugnacity, sympathy, and rivalry (for love) In the face of our scanty material this ought not to be indicative of the inherent prevalence of these traits at this nursery-school age, but should rather suggest that they merely happened to be observed by the writer more frequently than others, although with more material conclusions to that effect should be feasible Moreover, in naming the various character traits and then grouping the writer tried for the sake of terminological economy to generalize them as much as possible, yet he could not avoid the specification and differentiation of some traits, for their intrinsic characteristics were thus revealed Thus, for instance, the difference between *real* anger and anger *played* is of distinct importance, although both are only kinds of anger (*vide* cases 10 and 33, also 51 and 60).

The total number of traits—45—as already mentioned, does by no means include all character traits actually present at this nursery-school age, it represents only the traits that were observed by the writer. Another very important thing must be noted, viz., the situations-stimuli giving rise to the behavior-responses were so complicated that it was very often difficult to place the given character

trait under a generally accepted heading, and the writer had to "invent" a new character trait. This fact proves only how important it is to note the stimulus-situation as an inseparable part of the response-behavior of the subject. Thus, for example, merely noting of anger would be incomplete, for various situations would add notably to the quality and intensity of their corresponding anger responses. For this reason the ideal thing for such a study would be a cinema apparatus photographing the things we want to be preserved exactly, we should have then a record of not only the situations and their corresponding reactions *described* by a report, but also an exactly *copied picture* of them Still more ideal would it be to have a movietone for this purpose, one would thus have a *complete* record of the total expression of the behavior in question Thus, for example, in the case of Number 49 submission was inferred only but unmistakably by the submissive looking down of the subject, and by no sign else.

It ought to be self-evident that on the basis of a considerable number of observations made on certain children, the writer inferred their environmental background and conditions To cite one instance, the girl J.H. (54 months) likes to "boss" all other children and continually exhibits an air of superiority over them. She loves to play "mother and baby," but the only rôle she would choose is that of the mother unceasingly commanding and ruling "her baby." The writer inferred that J.H must have at home a baby brother or sister of whose attention on the part of the parents, or parent, she is jealous, and here an opportunity is found for compensation This conjecture was verified—J.H.'s father told the writer of her little baby sister of whom J.H often exhibits jealousy

Another thing worth noting is the fact that, the more the subjects were observed as whole individuals and the more their single acts were brought to the eye of the writer, the closer was their correlation, a thing, of course, one would expect, i.e, the continuous exhibition of certain acts is and should be indicative of one's total character and personality.

Résumé

1 In the introductory part of this study it was emphasized how it would be impossible to know and properly to understand the development of the character traits of the adult without study of the

development of the young child Moreover, to pass from the study of the infant's behavior to that of the adult without considering the behavior of the preschool-age child means breaking a single chain of development into two separate actually non-existent chains We also dwelt upon the difficulties as well as advantages in studying the behavior of the nursery-school children

2. The possibilities of observing in the nursery-school situations of all sorts, including various *emotional reactions*, are, it seems, so obvious from our instances that we hardly need to mention them. The controversy as to the number of emotions present in children can thus be at once settled—there are as many varied emotions as there are situations and stimuli calling them forth How many of them are innate and how many acquired?—in a way all of them are innate, i.e., their appearance is potentially existent, otherwise they could have never arisen; but whether they come to expression, and hence into existence, is a matter of circumstances. An emotion exists for us when we experience it ourselves, or observe it in others. Thus, for instance, the writer observed that boy J.R., one year old, was afraid of a toy-chick, teddy bear, and balloon. Now, then, what fundamental difference does it make whether the fear of the balloon is "acquired" or "innate" Most important is the actual fact that the child *can* and *does* exhibit fear, and whether he fears a furry animal, a strange looking sight, a balloon, or gets frightened by a sudden loud noise, makes materially no difference The importance, however, of such knowledge, when it comes to the practical question of reconditioning emotional responses is obvious without any special emphasis

3 From all the methods and results cited above, we learn once more how important it is for us not to be one-sided by confining ourselves exclusively to pin-pricking or tickling experiments in the laboratory As a matter of fact, the writer cannot see any suitable method for studying the character traits of the preschool child other than that of extrospection, particularly and mainly at the nursery school Moreover, any endeavor at "behavioristic objectivity" is here useless, for the nursery-school observations would be meaningless without our "speculative" interpretation since the behavior is more complex than that of the infant, and, on the other hand, no introspective account can ever be obtained from the child

itself and, therefore, the explanation must be found by the observer himself.

4 From his own observations in the nursery-school it seems to the present writer that in order to have a full and exact comprehension of any emotional state, one must needs know and take into account both the situation and whatever stimulus there may be, as well as its corresponding response. Observed cases yielded sufficient proof that different emotions may involve the same visceral changes or bodily movements, and therefore reliance upon response only would oftentimes mean misinterpretation. The criterion of an emotional state ought to be for us the stimulus-response as an actually undivided totality From these we may draw a corollary as to the possibility of an unlimited range of emotional experience, since situations may vary endlessly, involving ever so many corresponding responses

Conclusion

On the basis of his observations at the McGill Nursery School, a claim is made by the present writer that a very reliable, and perhaps the most accessible method of studying the character traits and emotional states of the preschool child in their appearance, as far as racial and individual characteristics are concerned, is that of merely observing his life in the nursery school Of course the forelying material is too meager to be considered as conclusive, but the data collected are, let us hope, quite suggestive of the possibilities of study and of drawing a continuation of the genesis of the human character traits and emotional behavior It seems as if once we have the development and number of character traits till the age of five, the further development is feasible. Naturally, in face of the difficulties one encounters in studying the behavior of children in general, particularly their emotional life, long attendance as well as patient and keen observation are the *sine qua non* for getting a considerable amount of particular data, such as emotional situations and emotional reactions. Only when an appreciable number of data are accumulated, are conclusive results warranted But is not the very characteristic of science endurance and patience and perseverence?

Thus one feels confident that only by securing reliable data from observations on infants and on children of nursery-school age may we hope that the fundamental problems concerning the emotional life will be solved if not in the early at least in the later future

References

1 Baldwin, B T Scientific method of studying preschool children. *School & Soc*, 1925, 21, 360-362
2 Bridges, K M Preschool character rating chart *Psychol Clin.*, 1928, 17, 61-72
3 ——— The social and emotional development of the preschool child London Kegan Paul, 1931. Pp. 277
4. Gates, G. S A test of ability to interpret facial expression *Psychol Bull*, 1925, 22, 120
5 Johnson, H M. Children in the nursery school London Allen & Unwin, 1929. Pp 345.
6. Jones, H E, & Jones, M C Genetic studies of emotions *Psychol Bull*, 1930, 27, 40-64.
7. Jones, M C Development of early behavior patterns in young children *Ped Sem*, 1926, 33, 537-585
8 ——— Study of emotions of preschool children *School & Soc*, 1925, 21, 755-758
9 Katz, D Development of conscience in the child as revealed by his talks with adults Chap. 29 in *Feelings and emotions: the Wittenberg symposium*, ed by M Reymert. Worcester, Mass, Clark Univ Press; London Oxford Univ. Press, 1928 Pp. 332-345.
10 Lewin, K Kindlicher Ausdruck (Film-Vortrag) *Ber u. d X Kong. f exper Psychol*, 1927, 145-148
11. Marston, L R Emotions of young children *Univ Iowa Stud.*, 1925, 3, No 3. Pp 99.
12 Sherman, M Differentiation of emotional responses in infants. *J Comp. Psychol*, 1927, 7, 265-284, 335-352; 1928, 8, 385-394
13. Watson, J B. Experimental studies on the growth of the emotions Chap. 2 in *Psychologies of 1925*, ed by C. Murchison Worcester, Mass. Clark Univ Press, 1926 Pp 37-58
14. ——— Psychological care of infant and child New York Norton, 1928. Pp 195
15 ——— Studies in infant psychology *Scient. Mo.*, 1921, 13, 493-515

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UNE MÉTHODE POUR ÉTUDIER LES TRAITS DE CARACTÈRE CHEZ L'ENFANT D'ÂGE PRÉSCOLAIRE

(Résumé)

Cet article essaie de montrer que l'on peut étudier avec succès le développement des traits de caractère chez l'enfant d'âge préscolaire au moyen d'une simple observation de son comportement. Les sujets ont été 12 garçons et 12 filles, âgés de 30 à 58 mois, tous étant élèves de la McGill Nursery School L'observateur a soigneusement noté leur comportement sans s'en mêler Quand il est venu une situation qui a causé une réaction

émotive, on a noté la situation et la réponse avec une précision soigneuse Les données obtenues comprennent des cas d'ingéniosité, d'intelligence, d'esprit inventif, et d'autres traits personnels, mais l'article discute pour la plupart ceux ordinairement appelés "émotions," "sentiments," et "dispositions." Ensuite on a classifié et disposé en forme de tables les données, pour indiquer la présence et la fréquence relative des divers traits de caractère aux divers âges A cause de la difficulté de trouver un nom exact en quelques cas, les tables ont rapport aux données originales reproduites dans l'article On recommande l'usage des photographies quand possible, bien qu'on ne s'en serve pas dans cette étude préliminaire Les données ici presentées ne sont pas assez pour avoir une constance statistique, mais elles indiquent d'une façon définie la grande variation de l'expérience émotive de l'enfant d'âge préscolaire, et les possibilités de cette simple methode d'observation pour montrer le rapport entre les simples réponses émotives des enfants et les traits de caractère plus complexes de l'adulte

ETZIONY

EINE METHODE ZUR UNTERSUCHUNG DER KARAKTEREIGENSCHAFTEN DES VORSCHULPFLICHTIGEN KINDES

(Referat)

In diesem Bericht versucht man zu beweisen, dass die Entwickelung der karaktereigenschaften des vorschulpflichtigen Kindes erfolgreich durch die einfache Beobachtung des Benehmens untersucht werden kann Als Versuchspersonen dienten 12 Knaben und 12 Madchen, 30 bis 58 Monate alt, die alle die McGill Nursery School [Pflegeschule] besuchten Der Beobachter notierte sorgfaltig ihr Benehmen, ohne zu storen Jedesmal, wenn eine Situation vorkam, die eine Affektreaktion (emotional reaction) hervorrief wurde sowohl die Situation wie die Reagierungsweise (reaction) mit peinlicher Genauigkeit notiert In den erhaltenen Befunden sind Falle der Findigkeit (ingenuity) der Intelligenz, der Erfindungsgabe (inventiveness), und anderer personlicher Eigenschaften mit eingeschlossen, aber der Bericht bezieht sich grossenteils auf diejenigen Eigenschaften die gewohnlich "Gemutszustande" (emotions), "Gefuhle" (feelings), und "Gemutsarten" (dispositions) genannt werden Die Befunde wurden dann klassifiziert und in Tabellen gebracht, um die Gegenwart und die relative Haufigkeit verschiedener Karaktereigenschaften in den verschiedenen Altern anzudeuten Weil es in einigen Fallen schwar war, eine genaue Etiquette zu finden, beziehen sich die Tabellen auf die ursprunglichen Befunde, welche in der Abhandlung wiedergegeben sind Es wird der Gebrauch, wo moglich, von Photographien empfohlen, obwohl man in dieser einleitenden Untersuchung nicht versucht hat, sie zu verwenden Die hier mittgeteilten Befunde sind zu gering, um irgendwie statistisch zuverlassig zu sein Sie weisen aber bestimmt darauf hin, wie weit sich das Bereich der affektiven Erfahrungen des vorschulpflichtigen Kindes erstreckt, und wie vielversprechend diese einfache Beobachtungsmethode ist fur die Verbindung der einfachen Affektreaktionen der Kinder mit den komplizierteren Karaktereigenschaften des Erwachsenen

ETZIONY

SHORT ARTICLES AND NOTES

CHANCE ORDERS OF ALTERNATING STIMULI IN VISUAL DISCRIMINATION EXPERIMENTS

LOUIS W GELLERMANN

In the typical visual discrimination experiment, subjects are required to make responses to the *right* or *left* of whatever apparatus is used. They are credited with correct responses on those trials in which they respond to the side of the apparatus on which the "positive" visual stimulus appears, and they are credited with errors when they respond to the other side It has been the practice of investigators in this field to present the positive stimulus either on the right or on the left side of the apparatus according to some "random" or "chance" order Sometimes a predetermined group of orders of alternating stimuli has been used, and in other investigations chance series of presentation have been made up every day just preceding the experiment Usually these presentation series have contained an equal number of *rights* and *lefts* The only typical exception has been when subjects have shown a definite position habit In such cases a number of successive trials to the *opposite* side is usually given in order to break down the position habit. It has been commonly *assumed* that such orders of alternating stimuli allow the subjects an opportunity of making only 50% of their responses correct through "chance" alone

In actual experience, however, it has been found that various "chance" factors such as habits of alternation may result in an accuracy as high as 70% How high the percentage of correct responses must be *in order to indicate discrimination* has always been more or less uncertain Few experimenters will accept as evidence of discrimination a record of 60 to 65% correct responses in a given series of trials Some experimenters do not regard an accuracy as high as 80 to 85% as much better than chance The uncertainty in connection with the interpretation of such results is due in part to faulty selection of orders of alternating stimuli Presentation series have not been rigidly tested to determine what their most probable chance score is Consequently, many series have been used which allow subjects to make relatively high scores purely through chance. It should be possible to find some presentation series which would give only low scores in the absence of discrimination In undertaking experiments on form discrimination in chimpanzees and two-year-old children, reported elsewhere in this issue (1, 2), the writer determined to use orders of alternating stimuli in which the most probable chance score would be 50% correct

All possible presentation series for 10 trials were examined There are

1024 possible combinations of rights and lefts in series of 10 Only those were chosen which met the following five criteria:

1 Each series must contain five rights and five lefts

2 No series could have more than three rights or three lefts in succession.

3 At least two rights and two lefts must appear in both the first and last halves of each series

4 Each series must contain only five reversals from right to left or from left to right

5 The series must offer a chance score of 50% correct from either simple or double alternation of response

The first three of these criteria were intended to give well-balanced series in which the formation of position habits would not be encouraged greatly. The fourth criterion was used because of the possibility of differential cues in the change of stimuli from side to side in some trials and not in others With 5 reversals in each series of 10 responses, the stimuli would be actually changed half the time, and altered but not changed the other half of the time. The fifth criterion was chosen to minimize the subject's opportunity of making more than 50% correct responses through habits of alternation which are relatively common in subjects in visual discrimination experiments. The 44 series which met these five criteria are as follows

1 R R R L L R L R L L

2 R R R L L R L L R L

3 R R L R L R R L L L

4 R R L R L L R R L L

5 R R L R L L L R R L

6 R R L L R R L R L L

7. R R L L R R L L R L

8 R R L L R L R R L L

9 R R L L R L L R R L

10 R R L L L R R L R L

11 R R L L L R L R R L

12 R L R R L R R L L L

13 R L R R L L R R L L

14 R L R R L L L R R L

15. R L R L L R R R L L

16 R L L R R R L R L L

17 R L L R R R L L R L

18 R L L R R L R R L L

19 R L L R R L L R R L

20 R L L R L R R R L L

21 R L L R L L R R R L

22 R L L L R R L R R L

23 L R R R L L R L L R

24. L R R L R R L L L R
25 L R R L R L L L R R
26. L R R L L R R L L R
27 L R R L L R L L R R
28 L R R L L L R R L R
29 L R R L L L R L R R
30 L R L R R L L L R R
31 L R L L R R R L L R
32 L R L L R R L L R R
33 L R L L R L L R R R
34 L L R R R L R L L R
35 L L R R R L L R L R
36 L L R R L R R L L R
37. L L R R L R L L R R
38. L L R R L L R R L R
39 L L R R L L R L R R
40 L L R L R R R L L R
41 L L R L R R L L R R
42 L L R L R L L R R R
43 L L L R R L R R L R
44 L L L R R L R L R R

These series may be combined with ease to make longer series In making such combinations it is necessary to exercise care in connection with only the second and fourth criteria given above. The other three criteria are not affected by combining series If the fourth criterion were applied to a series 20 trials in length, it would allow only 10 reversals When applied to the combination of series, this means that series ending with R may be followed only by series beginning with R Likewise, only series beginning with L may follow series ending with L With this fact in mind, the application of the second criterion, which prohibits more then three rights or three lefts in succession, makes possible 638 different series 20 trials in length All of these will give a most probable chance score of 50% correct

References

1 Gellermann, L W. Form discrimination in chimpanzees and two-year-old children I Form (triangularity) *per se*. *J Genet Psychol*, 1933, **42**, 3-27.

2 ——— Form discrimination in chimpanzees and two-year-old children: II Form versus background *J. Genet Psychol.*, 1933, **42**, 28-50

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THE FUNCTIONS OF REFLEXES IN THE BEHAVIOR DEVELOPMENT OF INFANTS

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The ultimate objective of all psychology is to further an understanding of human behavior, complex human behavior, as it is known in present-day society Early psychology followed the lead of more established sciences in attempting to determine the simplest elements and to construct concepts of behavior as it aggregated and became more complex. The simplest types of behavior were called reflexes and elementary textbooks in psychology customarily contained a list of these simple reflexes, another list of slightly more complicated responses, called "instincts" and, upon these inherited, relatively unmodifiable, traits acquired characteristics presumably developed. The identifying characteristics of a reflex as given in some of the more common textbooks are (*a*) that they are simple stimulus-response units, (*b*) that they involve a direct route through the nervous system, (*c*) they are very prompt in their reaction, specific, and predictable, (*d*) they have little or no inhibitive or modifiable characteristics and they usually persist throughout life (4) Woodworth (11) says, "They are quick, definite, given to specific response, involuntary, and often unconscious, permanent and inherent within the organism, they are unlearned and always ready for action" Dashiell (3), discussing the same subject, says, "The elementary action unit into which all behavior can be broken down is that sensorimotor function called a reflex action—or better reflex reaction the name hints at the simplicity and the promptness with which this kind of response follows upon stimulation, [however], the majority of reflexes are to some degree compound; several sensory impulses combine to produce the reaction, which may itself be multiple, and thus several different arcs work in cooperation"

These definitions are taken from three widely used textbooks in introductory courses of psychology They all stress the simplicity, the specificity, and the promptness of the reflex action, and they all at least imply that an understanding of our complex behavior has its beginning in an understanding of these more elementary reactions Dashiell makes a point of this when he says, "What is found true of the simple units we may expect to find holding true of larger action units as well, and by becoming familiar with the principles as they reveal themselves on a simpler plane we should be able the more readily to recognize their operation in a man's behavior, however complex or however subtle . . the difference is only a difference of degree and in the present chapter we are bearing in mind only the scientific rule of explaining the complex in terms of the simple" (3)

This old reliable scientific principle has, however, in the past few years received considerable challenge and there is a growing tendency, particularly in the biological sciences, to talk in terms of "organismal" reactions rather than elemental Ritter and Bailey (9), discussing the present assimilation

of the idea of unification in all fields of scientific endeavor, say "In the natural sciences the idea has become established on numerous masses of objective reality highly diverse in character and remote from one another The most definite outgrowth of the conception as applied to man is found in the extent to which present-day clinical medicine and educational theory are recognizing the importance of the 'whole man' and 'the whole child'" In the field of psychology particularly the Gestalt school has done much to further the idea of "wholeness," especially with respect to the nature of perception, and Koffka (6), writing on the nature of reflexes and instincts, says "If, by emphasizing the common characteristics of both types of behavior we can now close the gap which previously seemed so wide between the instincts and the reflexes, this does not signify a return to the point of view that instincts are chained reflexes. On the contrary we have reversed the procedure, for it is no longer the reflexive mechanism which is the fundamental fact of behavior, but the characteristics of 'closure' as they appear most clearly in the instinctive activities" Coghill (2), after intensive study of the neuro-functional development of the Amblystoma, has evolved a thesis of *individuation*, or a progressive restriction of zones of adequate stimulation and response out of a total organismal integrated reaction-pattern Referring to the elementary characteristic of the reflex, he contends that "If there is such a thing as 'unit-reaction' in nervous function it is the total pattern, and the development of specific nervous function, such as reflexes of different grades, is an analytic process not a synthetic one In so far as the development of behavior is known in vertebrates, all reflexes emerge as partial or local patterns within an expanding or growing total pattern that normally is from the beginning perfectly integrated They become partial or local only overtly." Lashley (7), who has approached the problem of behavior through studies of cerebral localization, unequivocally disclaims the usefulness of the reflex theory as a key to understanding human conduct. He states. "In the study of cerebral functions we seem to have reached a point where the reflex theory is no longer profitable either for the formulation of problems or for an understanding of the phenomena of integration. And if it is not serviceable here, it can scarcely be of greater value for an understanding of the phenomena of behavior I believe that there is ample evidence to show that the units of cerebral function are not single reactions, or conditioned reflexes as we have used the term in America The nervous unit of organization in behavior is not the reflex arc, but the mechanism, whatever be its nature, by which a reaction to a ratio of excitation is brought about"

These quotations represent controversial points of view as to the underlying principles involved in the mechanism and the development of behavior The bulk of the experimental evidence supporting these contentions has been in the field of animal psychology, though recent studies in infant behavior have essayed to interpret their findings in terms of these

general principles. The early studies of infant behavior were limited largely to studies of reflex activities, and, since it was known that the cortex of the newborn infant was in a large measure unmedullated and, presumably, non-functioning, this seemed logical But the relationship of these reflex reactions to maturation and learning has been given little scientific consideration. In general, most child psychologists and educators have adhered to the chain-reflex theory of development They have assumed that infants are born with certain specific reflexes and, by a process of conditioning, complex human behavior is fashioned. Watson's early work on the primary behavior equipment of newborn infants and its development by a process of conditioning is familiar to all students of psychology The bulk of the experimental studies of infants has followed this general principle, viz., that behavior develops from relatively simple reflex-patterns to complex integrated wholes Some more recent writers have taken the stand that there are very few specific reactions to definite stimuli in the behavior repertoire of the newborn infant Pratt, Nelson, and Sun (8) contend that: "The infant at birth represents an organism in which differentiation has proceeded to the point where there are many effectors and many receptors. Its behavior, however, is generalized That is, stimulation of almost any group of receptors by almost any kind of stimulus will lead to a response in almost any part of the organism The reaction tends, however, to manifest itself most strongly in that part of the organism which is stimulated, and from there spreads out with decreasing frequency and intensity to other segments of the body This does not mean that the activity within any given segment is well coordinated . . The newborn infant is equipped with quite a number of reflexes, but the degree of their specificity and their significance seem to have been unduly exaggerated" Shirley (10), basing her conclusions on an intensive study of 25 infants over a period of two years, endorses Coghill's theory of individuation She remarks that, in the human infant at birth, "Individuation of some reflexes has already occurred Nevertheless, the sudden appearance of integrated locomotor skills that the babies apparently had never practiced is in accordance with the development of locomotion in amblystoma The law of integration first and individuation into reflexes later probably applies to babies as well as to lower vertebrates Certainly it is impossible, even by prolonged and careful observation, to see the building up of locomotion from reflexes" These quotations are taken from two recent publications concerning infant behavior and they indicate a trend of child psychologists to renounce the chain-reflex theory of the development of behavior

There is in the behavior development of the infant evidence supporting both of these theories Certainly, the early prancing or walking movement of the newborn infant is a localized segmental reflex functioning at birth Irrespective of the theories concerning the process of behavior development, it is certainly safe to assume that those behavior patterns which manifest

themselves soon after birth are innate in character and they probably have a definite ascertainable relationship to the course of development It matters little whether the genetic development of human conduct is an aggregation of connections or a process of individuation, the primary problems confronting the infant psychologist are (1) the determination of both specific and general reactions of newborn infants, and (2) the interpretation of the relationship between these early infantile reaction patterns and subsequent behavior development

The behavior repertoire of the newborn infant embraces two large divisions (*a*) those activities which are generalized body action, non-specific, and, so far as determinable, are not actuated by external stimuli, commonly called "spontaneous activities", and (*b*) those reactions which are definitely in response to specific external stimulation These reactions, although subject to more or less individual variation, are nevertheless made in response to, and can be interpreted in terms of, definitely accountable stimuli. There are unquestionably in the behavior reactions of the newborn infant patterns of response which are specific, and some which are both specific and localized. That is, some specific reactions of newborn infants involve a total body pattern, others are more or less localized to specific members or muscle groups For example, the Moro reflex is a total body pattern which may be elicited by any number of stimuli, but it is, notwithstanding, a definite reaction pattern A repetition of the same stimulus elicits essentially the same type of reaction pattern Reactions to a loud sound, postural adjustments to changes in the plane of the long axis of the body, etc, constitute total body responses On the other hand, blinking to a tap on the face, tendon and certain cutaneous reflexes are examples of reactions which are relatively localized to limited muscle groups

In previous studies of infant development little consideration has been given to the relationship of these early reflex responses and subsequent behavior development except in a few isolated cases such as the alleged pathological significance of the persistent "Babinski" or the late appearance of the Moro. The studies of infant development have tended rather toward the establishment of norms of behavior. Infants are rated in terms of the chronological age at which they attain a certain postural reaction, say sitting or standing, without due credit being given to the process by which that ability was attained Considerable developmental significance has always been attached to the age at which an infant sits, stands, and walks; and in recent years it has been acclaimed by several writers that acceleration in these traits is suggestive of superior endowment Gesell (5) says "The growth characteristic of the infant must prefigure in some ascertainable manner the growth characteristics of maturer years and even behavior traits of those years" During the past decade measures of these "growth characteristics" have sprung into considerable vogue in the form of scales of standardized tests Most of these scales of measurement for infant develop-

ment include such items as "holding the head erect in a prone position," "sitting with support," "sitting alone," "standing with support," "standing alone," etc, and are considered to be of developmental importance It is now well established that many infants only a few hours old, when in a prone or sitting position, will hold the head erect for a few moments; many will momentarily sit with support, stand with support, and take walking or prancing steps If an infant 10 hours old will support his body weight when held by the fingers or at the axillae, what can be the developmental significance in rating an infant 10 months old who does the same thing? It is admitted that the way the infant 10 months old stands with support is very different from the way the infant 10 hours old stands with support, and it is the business of the infant psychologist to bring these distinctions into relief so that they may be recognized and their significance understood by the less experienced worker

Neurologically, the difference in the postural responses of the neonate and those of the older infant are probably well defined; the postural responses of the neonate are undoubtedly controlled at a lower, probably segmental level, while those of the older infant are cortically controlled, at least in part

A study of the reflex behavior of 125 newborn infants by Chaney and McGraw (1) indicates that specificity of response to many different stimuli has developed at the time an infant is born. Some reactions are more specific than others. The grasping and Moro reflexes are definitely determined behavior patterns functioning with a high degree of specificity at birth

Since these reactions occur soon or immediately after birth, they are presumably unlearned and reflexive in quality These early reflex responses, whether localized and specific or total-body reaction patterns, are, it would seem, precursors of, and in some definite way related to, the controlled muscular development of the growing infant For example, the grasping reflex is a precursor of prehension, the Moro of reaching, primary sitting, standing, and prancing postural responses are forerunners of the assumption of an erect posture and ambulation. A characteristic digital posture of the neonates when the fingers are in extension is a flexion of the distal phalanx of the index finger, a flexion and adduction of the distal phalanx of the thumb, and complete extension of the little finger This would seem to be a precursor of the prehensile use of the index finger and thumb Whether these early reactions disappear and cease functioning when cortical control emerges or whether they become an integral part of the cortical reaction is a matter for future investigation In any event, the process of development from these primary reflex responses to definite muscular control is very gradual and transitorial phases are evident

Outstanding phases through which a course of development passes from reflex to muscular control appears to be as follows

1 *Passivity*—that stage when the organism fails entirely to react to the stimulation

2 *Reflex*—that stage when the infant responds in a definite pattern to a particular stimulus but the response is of short duration and not under cortical dominance

3. *Dyssynergia*—marked by an oscillation of the responding organism—a lack of equilibratory control in sustaining the developing pattern or reverting to a less mature reaction-pattern

4 *Inhibition*—marked by an apparent inhibition of a reflex response.

5. *Control*—denoting muscular control in a given response

6. *Synergic integration*—marked by the control of antagonistic responses so that functionally they are integrated

These stages are well illustrated in the assumption of an erect posture At the time of birth some infants are decidedly passive and show little resistance to the pull of gravity, others have already reached the reflex stage and momentarily support their body weight when given a little assistance. As the baby develops in control, marked dyssynergia is noted He gains control of the movements of his head and neck before he has control of the trunk and lower extremities Finally, when he has developed sufficiently to stand alone momentarily, dyssynergia is less frequent, and this development of standing has an inhibitive effect upon his "dropping" down to a sitting posture before he is able to *sit down* cautiously There is, so to speak, an inhibition of an opposing function A little later he gains control of standing and sitting and the process of getting up and its antagonist, getting down, become integrated and under the complete control of the child

So it would seem that the true definition of a reflex is not a question of simplicity of responses or limited synaptic connections, nor is it a matter of non-modifiability or localization or precision of the reaction pattern The term reflex should include all those reactions of the newborn having a characteristic pattern of reaction to known external stimuli, whether the reactions are total body patterns or localized and specific Then the question arises as to the importance of the primary reflex patterns in the process of controlled muscular development

Conclusion

So far as the behavior of the newborn and growing infant is concerned, there is evidence supporting antagonistic theories on the nature of neuromuscular growth Both localized and total-body reaction patterns are present in the behavior of the newborn infant. These reaction patterns, although distinct in type of response, are subject to individual variability and modifiability So it would seem that the old psychological definition of a reflex is in line for revision, so as to include all those reactions of the newborn (whether localized or a total-body response) having a discernible characteristic pattern Certainly these primary reflex responses of the newborn bear some ascertainable relations to the controlled muscular behavior

of the older infant, young child, and adult Just what the nature of that relation may be is a matter for future investigation There is as yet no conclusive evidence as to whether or not behavior metamorphosis as observed in the growing infant is a process of aggregating synaptic connections or a process of "individuation" or inhibition of accessory responses Certainly, the change from reflex or subcortical to controlled or cortical behavior in the infant is very gradual There is no evidence of a sudden shift from one type of reaction to another, hence no indication of a sudden maturation of function As a matter of fact, the aspect of dyssynergia accompanying the emergence of any new postural response in the developing infant is highly suggestive of trial-and-error learning Learning and maturation are not two distinct processes but are two aspects of the same process To attribute behavior growth in infants more to one than the other is, therefore, unwarranted There comes a time, however, due to the ripening of neural structures when systematic practice of a given function will have greater effect upon improvement of performance than it would at any other time. To attempt systematic practice of a particular function before the neural structures have obtained a degree of maturation is ineffectual The performance of a given function does not indicate that structural maturation is completed. To fail in the practice of a given function when the time is ripe curtails improvement in not only the overt performance but probably lessens future maturing of the particular structures involved

References

1 Chaney, L B, & McGraw, M. B Reflexes and other motor activities in newborn infants *Bull. Neur Instit.*, 1932, 2, 1-56

2 Coghill, G. E The early development of behavior in Amblystoma and in man. *Arch. Neur & Psychiat*, 1929, 21, 989-1009.

3 Dashiell, J. F Fundamentals of objective psychology Boston Houghton Mifflin, 1928 Pp xviii+588

4 Gates, A I Psychology for students of education (Rev ed) New York Macmillan, 1930 Pp 627

5 Gesell, A. Infancy and human growth New York Macmillan, 1928 Pp 418

6 Koffka, K The growth of the mind (Trans by R M Ogden) London Kegan Paul, 1924 Pp xvi+383

7 Lashley, K S Basic neural mechanisms in behavior *Psychol Rev*, 1930, 37, 1-24.

8 Pratt, K C, Nelson, A K, & Sun, K H The behavior of the newborn infant *Ohio State Univ Contrib Psychol*, 1930, No 10 Pp ix+235

9. Ritter, W E, & Bailey, E W. The organismal conception *Univ Calif Publ Zool.*, 1927, 31, 307-358

10 Shirley, M M The first two years (*Univ Minn Instit Child Welfare Monog Ser*, No 6) Minneapolis Univ Minn Press, 1931. Pp 227

11 WOODWORTH, R S Psychology A study of mental life. New York: Holt, 1921 Pp 580.

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A CHILD'S ATTAINMENT OF THE SENTENCE

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In a former paper (6) I suggested the division of the course of speech development into four main stages, using as a criterion the average length of a sentence in a representative series of sentences. They were in brief single words; early sentences, averaging more than one word and less than three, short sentences, ranging from 3 5 to 4.5 words, a transition stage, and the complete, or better-*established* sentence, averaging 6 5 to 7 5 words The short-sentence stage is reached simultaneously with the "stable ratio" of parts of speech comprising the vocabulary, i e, when verbs have increased to 20 to 24% and nouns fallen to 50 to 60% of the total words The established sentence is attained at approximately the same time as the mastery of inflections.

In order to test this matter more thoroughly I recorded conversations of my youngest daughter, T, each month with two exceptions from the age of 16 to 43 months, 6 of these samples ranged from 10 minutes to half an hour in length, while the other 20 lasted for an hour each A complete record was kept of her vocabulary from the first words at 14 months to the age of 31 months; her vocabulary was again collected at the age of 3 years.

In this paper the sentence stage as revealed in the conversations will first be examined; next, some peculiarities of this child's language development will be discussed, and, finally, the appearance of the chief forms of the sentence will be summarized.

On the whole, this child has enjoyed excellent health She took her first step two weeks after her first birthday, while right-handedness was definitely established at 14 months. Her associates were chiefly her parents and sisters, the youngest of whom was 5 years older than she.

SENTENCE STAGES AND THE CONVERSATIONS

It will be noted that the total number of words uttered during an hour increased greatly, although not entirely consistently, the child's volubility varying partly according to her own activity, partly according to her health. The phenomenal number of 1817 words at 38 months were given while seated beside me drawing pictures and telling stories about them, while the drop in loquacity at 25 months reflected lessened energy after an illness The average number of times each word was used ranged from 20 at 22

TABLE 1
THE SAMPLE CONVERSATIONS

Sentences stage	Age in months	Vocabulary size	Conversations: Words: Total number	Conversations: Words: Average length	Conversations: Sentences: Percentage incomplete	Conversations: Sentences: Percentage simple
Single words	14	2				
	15	4				
	16	7	244			
	17	13				
	18	20	199*			
	19	25	119*			
	20	28	226*			
Early sentences	21	31	441	1.2	100.0	100.0
	22	40	570	1.4	100.0	100.0
	23	58	515	1.3	98.7	100.0
	24	82	416	2.0	95.0	100.0
	25	92	313	2.3	98.5	100.0
	26	90	602	2.3	91.8	100.0
	27	101	484	2.3	93.2	100.0
	28	130	450	2.9	96.3	100.0
	29	185	672	2.7	92.5	100.0
	30	318	843	2.7	89.0	100.0
Short sentences	31	506	908	3.4	62.9	98.9
	32		680	3.6	49.3	100.0
	33					
	34		1303	3.6	55.6	98.4
	35		1248	3.6	51.7	98.6
	36	780	1124	4.3	50.0	98.0
Transition stage	37		1096	4.8	37.0	95.7
	38		1817	5.7	38.8	90.3
	39		1342	5.3	34.9	93.8
	40		250†	5.0	14.0	92.0
	41		317†	5.2	25.0	95.0
	42		1093	5.7	9.9	71.4
Established sentence	43		327†	6.5	10.0	82.0

*Half-hour record
†50 to 60 sentences only

months to 10 at 27 to 29 months, 6 at 30 and 31 months, and 4.2 at 42 months. The small vocabulary and a vast amount of repetition are evident in the early conversations, while the large vocabulary and almost complete disappearance of repetition are clear in the last one.

Single Words. This stage extended from her first word "baba" at 14 months to the first sentence "Dadda car" at 19 months, but it was not for another 6 weeks that she employed even two-word sentences at all freely. *She had 25 words in her vocabulary when she first combined two and 31 words when she was fairly launched in the early-sentence stage.*

Early Sentences. This stage was rather prolonged—10 months—due to the fact that her period of inhibited speech lasted abnormally long. In the conversations sentence length progressed from an average of 1.2 to 2.7 words (with babble included), while incomplete sentences at first accounted for 100% of the total and gradually decreased to 89%. The ratio of nouns to verbs in her vocabulary of 185 words at 29 months was 68.12, in that of 318 words at 30 months it was 58.19.

Short Sentences. There is a sudden change between the 30- and 31-month records when sentence length increased from 2.7 to 3.4 words. At the same time the vocabulary reached 506 words (proper nouns being omitted from this and the three-year vocabulary), the stable ratio was attained (nouns 59%, verbs 20%), and the percentage of incomplete sentences dropped to 63. The 30th month marked the end of her period of inhibition and she learned words with a rush, averaging 4.8 new words per day this month and 6.3 the next. At this time—the 30th month—she achieved her first conjunction—and—, her first pronoun—me—, soon acquiring three more; increased her prepositions from 2 to 5 and the next month, to 15, and used her first "where" and "what" and her first compound sentence. The next month showed a marked drop in the percentage of incomplete sentences in the conversation—to 49.3, this was largely due to the common use of the first personal pronoun which had been but seldom employed during the previous month.

Further progress during this stage was slow. The first complex sentence appeared in the 33rd month and personal pronouns were added to the total of 14. At three years she had attained a vocabulary of 780 words, her sentence length averaged 4.3 words, one-half of the sentences in the sample were incomplete, and only 2% were compound and complex. At this time, only the barest beginning had been made in the inflection of verbs.

Transition Stage. At 37 months the average sentence length in the conversation had increased to 4.8 words, the percentage of complex and compound sentences had more than doubled over the previous month, reaching 4.3, while the percentage of incomplete sentences made a sudden drop from 50 to 37%, staying at about this level for three months. The next month the sentence length reached 5.7 words and here it remained for five months. Compound and complex sentences increased to 9.7% at 38 months and finally reached a maximum of 28% at 42 months. The initiation of this

stage depended on the general adoption of the copula which had been almost entirely absent before this. The chief advance during this stage lay in the mastery of inflections It was a surprise to find the transition period so prolonged, perhaps this is not typical.

Established Sentence This was attained in the 43rd month with a sentence length of 6 5 words in a series of 50 sentences If we calculate that she added words at the same rate as she had from 31 to 36 months, i e, 1.8 a day, her vocabulary at this age would have contained 1058 words

Comparison with Other Authors In Smith's (7) extensive investigation of sentence development in preschool children the early-sentence and short-sentence stages are present and perhaps the transition stage, but not the established sentence according to my definition, since the average length never exceeds 5 8 words, while the average for 16 five-year-old children was only 4.6 words The hour conversations of these children were also very much smaller than with my daughter, averaging 78 words for the two-year-old children, 233 for the three-year, and 400 for the four- and five-year-olds

That the situation of these preschool and day-nursery children is a very different one from that of a child at home with her parents is evident both from my results and those of other investigators. In all-day conversations, the Brandenburgs' (2) four-year-old daughter used from 925 to 1495 words per hour, while my daughter R (4) at the same age used from 464 to 1333 The average sentence length of the Brandenburgs' child was 6 6 words at three years, 7 5 at four, of Kirkpatrick's (3) daughter at four 7 words in 100 sentences, and of Boyd's (1) daughter in 1250 sentences 6 4, 6 9, and 7 5 at three, four, and five years, respectively

Period of Inhibited Speech Development

This baby started on a normal path of speech development, but soon became side-tracked with her own babble and did not return to a more typical course until she was two and a half years old.

Character of the Earliest Words The earliest words appeared first in her spontaneous babble, they normally developed into real words through repetition by her associates. This was true notably of "mamma," "dadda," and "baba" A few expressions, however, became words for her entirely through her own constant use of them, never having been adopted by us All the first words are used emotionally, not intellectually, with no conception of the real nature of language, i e, that one word means one thing.

"Gadda"—an expression of interest and admiration—became a stumbling block for this child by developing into a universal word and obviating the necessity of the application of different words to different objects From the age of 14 to 27 months T gradually acquired a hundred words in her vocabulary, but many common, important terms were lacking, such as milk, bread, butter, water (for drinking), bunny, flower, bird, the names of three of her sisters, etc Apparently "gadda" was so reinforced by

habit in regard to these everyday objects that she could not or would not attempt their real names The names of new objects that were conditioned in some pleasant or startling way and that were also easy of pronunciation were the only ones learned during this period

There were many times that we could not understand what she wished to say to us and this would annoy her Our third daughter, R (see 5), was much more inhibited in her speech development than was T, using only 48 words at the age of three and being equally unwilling to say anything for the *above list of important words, but we had little trouble in understanding* her until the age of 38 months when she began to tell stories I believe the reason was that R, although in general her language was much further from English than T's, had no universal word, depending on gesture to make us comprehend her meaning, whereas T confidently expected us to know which of the countless possible "gaddas" she had in mind

Her Babble Most little children say nothing when they cannot say something approximating the term they wish, but T was different for her talk was full of fill-ins, some of which gradually evolved into fairly definite meanings, but most of it being ephemeral chatter In her conversations babble amounted to 76% of her talk at 16 months, 40% at 20 months, 19 and 22% at 24 and 25 months, 7% at 26, and 6% at 27, having entirely disappeared at 28 months In the samples from 21 to 27 months, babble is included in calculating the average sentence length, since it formed an integral part of her conversation

When she was two years old we recorded her all-day conversation, which totaled 4005 words, of which 20% was babble There were 63 different words, and 47 different babble expressions, some very similar, others totally different

Her Original Words. The most interesting of her original expressions will be briefly considered

"Gadda"—originally appearing as "ga" in her 16th month and used in connection with objects either desired or admired—gradually grew to be the most important word in her vocabulary, being applied to all things for which she did not say the name, the most familiar as well as new, unknown ones In her 21st month she first combined an adjective with it, saying "Poo' gadda" in regard to a flower that was injured and also when one of her small girl cousins cried For the next three months it was the most used word in the conversations, appearing 110 times in the sample at 22 months, the next most common expression—"ran away"—occurring less than half as often, 48 times. It kept its importance until the great change in her speech in the 30th and 31st months In the former she learned "ding" for thing and soon "gadda" was used only for unknown objects or decidedly difficult words "B'oom" (bloom) and the name of one sister were said in the 30th month, bunny, rabbit, bird, and her other sisters' names achieved in the 31st

"Num"—perhaps an imitation of the sound of eating—appeared in the 21st month as an expression for food and occasionally for drink It soon came to mean a verb to eat, the dining-room table, all manner of dishes, mouths of people and animals, and birds' bills "Gadda num" usually meant any food that she wanted, but sometimes signified that a rabbit, squirrel, or bird was eating "Num in a car" was her expression for a picnic "Daddy, num" was used when calling her father to dinner or asking him to serve her "Poo' num" meant that the table was not set, or again that a cup was broken "Num ran away" was said when she saw the table cleared after a meal "Num" flourished for ten months, in her 22nd- and 26th-month conversations it was the third most common word, at 25 months, the second The proper words began to appear in the 29th month· butter, cup, picnic, in the 30th, drink, milk, eat; in the 31st, bread, table, sugar, breakfast, dinner, in the 32nd, food "Num" had practically disappeared by the end of the 31st month and was noted but once in the 32nd, being used in regard to a cereal for which perhaps she did not know the name

"Gē" appeared in her 20th month in connection with huckleberries; its origin is a mystery It was used for all sorts of berries and also plums, grapes, and peas until her 31st month when she said berry.

"Nu hu nu" meant nothing, being used from the 22nd to 32nd month.

"Gō" meant reading matter From her 18th month she had been in the habit of "reading" from books with miscellaneous babble, from the 25th to the 28th month this had become stereotyped into "ah-go-whan," and finally in her 29th month she shouted "Go, go" as her sister was carrying off a booklet she wanted. "Go way" meant that she wished me to put away a newspaper, again, she pointed to a word printed in large letters and said "Go." She did not use go in our sense until after her 32nd month This peculiar "go" disappeared rather shortly

"Cō" for cold came to mean outdoors, blankets, and sweaters

"Nă' " (first used in the 21st month) for nap meant asleep—"ba a na" for fast asleep—and also beds "Poo' na'," she would say in regard to an unmade bed. Cot and bed appeared in the 30th and 31st months respectively

"Bă' " meant all water except for drinking purposes On seeing two bald-pates in the Canadian River, she shouted "Ow' we a ba,' " i e, "Owls (she would not say ducks) take a bath."

Effect of Sickness A serious illness during her 25th and 26th months reduced this child's speech to a minimum In fact, during the latter month her total vocabulary decreased two words. While she was sick, her speech was almost entirely utilitarian It was concerned first with getting what she wanted "Mamma, na' " when she wished to be held, rarely "Num" for food or water, "Gadda" when she wanted the Victrola played Secondly, it was used to ward off evils "Bad num" was her reaction to all medicines, "May" the response to all activities of which she disapproved,

"Way, manna" and "Way, num" when she wanted a toy cat or water taken away, and simply "Way" for all medicines Finally, there was a very little interest in her surroundings chiefly in connection with the puppy. "Bah num," "Bah ran away" "Nu hu bah" (there dog)

This experience was a striking indication that most of a child's speech activities are an expression of surplus energy

Period of Rapid Speech Development

In her 29th month the little girl became less unwilling to try new words, for she added 52 new terms to her vocabulary, but the common, everyday objects were still "gadda" and "num" During the next month her inhibition was overcome in regard to the majority of simple, important words that she heard, and the next month all of the old stumbling blocks had been mastered From refusing to try anything, she became ultra-imitative, even exhibiting echolalia (repetition of words spoken to her), something none of her sisters had done This phase persisted for some time, being still present to a small degree in her 36th month

After her great spurt in the 30th and 31st months, she settled down to a normal, leisurely rate of speech development, adding new words for the next five months at an average rate of 1 8 words a day

At 35 months she began adding *s* for the plural of nouns, and a month and a half later used her first possessive nouns, mastering their technique in about two weeks Soon after this she started asking the meaning of words "What 'evening' mean?" "What 'no' mean?" "What 'that's all' mean?"

The mastery of inflections took place from the age of three to three and a half At 32 months her only way of showing the future was with the present participle "My goin' deep (sleep)" At 34 months she occasionally indicated the past in the following manner "My be bad long ago" The next month she sometimes employed *used to* in the same way In the 36th month she rarely said *did*, but as a rule the present stood for all tenses One device for indicating the past was "After me eat beakust, hab a marshmallow" She now began to use singular verbs to a small extent "I goin' ask Daddy what dat means He knows" The future with *will* first appeared at this time, but was not fully established until several months later The past was occasionally used at 39 months but not thoroughly mastered until the 42nd month

Different Forms of the Sentence

Questions The first questions were as to the whereabouts of things At 18 months T evidently asked for her father after his departure on a journey by "Dadda?" Such single-word questions were rarely used for a year, the first *where* appearing at 30 months

The names of things were occasionally asked from 24 to 31 months by

pointing to the objects and a questioning "Mamma, gadda?" *What* first appeared at 31 months

What for was first heard at 38 months, *why* and *how* at 40 months, and *when* at 43 months

There was much trouble in mastering the form of the question, from 42 to 52 months most of her inquiries being worded like declarative sentences, only the intonation differing It was not until she was five and a half years old that this difficulty was entirely overcome

In her conversations the first questions appear at 25 months, when they make up 3% of the sentences After this there is an increase, reaching a maximum of 23% at 34 months, later sometimes dropping to 2 or 3%, but rising again to 11% at 39 and 42 months and 18% at 43 months.

Negative Sentences Negation was first expressed in the 20th month by "na" for no, the next month by "may," which served for *no* until the 26th month During her 24th month she used the very same words for *there is* and *there isn't*, "Nu hu moo" meaning first "There is no moon" and later "There is the moon"—the only distinction being in the manner of saying, wistful in the first case, triumphant in the second *Not* was learned in the 29th month, but not always used, for the omission of any negative was a common practice from the 33rd to 38th month, an extra emphasis on the verb taking the place of not, as "*Want* Mamma ran away" From 40 to 46 months she over-compensated by consistently using double negatives, but after that had no more trouble with these sentences

Up to the middle of her 29th month her *no* was volitional entirely, but two weeks later she was using the intellectual *no*

Affirmation was shown at two years by saying "gadda," and during the next two months by a little high-pitched laugh Later she usually repeated the last part of the question, and this method lasted till some time after she was three, although at 36 months she sometimes said "yes."

Compound and Complex Sentences The first compound sentence appeared 11 months after the first simple sentence, the first complex one month after the first compound. The first relative pronoun, *what*, was heard in her 36th month, her second, *who*, at 52 months, but was little used, *what* being her standby, despite repeated corrections, until the age of 63 months

REFERENCES

1 BOYD, W The development of sentence structure in childhood *Brit J Psychol*, 1927, 17, 181-191

2 BRANDENBURG, G C, & BRANDENBURG, J Language development during the fourth year The conversation *Ped Sem*, 1919, 26, 27-40

3 KIRKPATRICK, E A Fundamentals of child study New York: Macmillan, 1910 Pp 384

4 NICE, M M Concerning all day conversations *Ped Sem*, 1920, 27, 166-177

5 ——— A child who would not talk *Ped Sem*, 1925, 32, 105-143

6. ———— Length of sentences as a criterion of a child's progress in speech *J. Educ Psychol*, 1925, 16, 370-379.

7 SMITH, M E An investigation of the development of the sentence and the extent of vocabulary in young children. *Univ Iowa Stud*, 1926, 3, No 5 Pp. 92

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A NOTE ON A CHILD'S DREAM

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In view of the continuing misinformation as to the subject matter of psychoanalysis [the recent speculations of Jastrow (1) being at the moment in mind], I take the opportunity to submit a specific item drawn from the factual realm instead of from the library, as is customary The item is not intended to be a random sample, it is presented because it is representative in the sense of being unusually clear, unitary, and free from errors of technique in so far as I am aware.

The subject is a boy, chronological age 3.9, IQ estimated at 140±20, the middle child of three in an American family of marked educational and slight economic superiority, history without particular interest The event occurred at about 3 A M, and is reported as nearly as possible in the words actually used (recalled about seven hours later):

"Daddy—come here." (Note of marked anxiety, close to tears, in the voice) "I had an awful dream"

> (Analyst's ["Daddy's"] mental processes and reactions, and analytic comment. Anxiety is wholly genuine, and at this age, when the 'ego' is weak and has a good many strains to bear, it is best to modify as many of these as possible, further, training in the mastering of anxiety by facing it consciously is probably desirable. Go to him and stand beside his bed, hold his hand In technical terminology, this corresponds to cultivating the positive transference, though by definition there can be no transference proper in a young child, less technically, it is simply establishing rapport and confidence, so that the necessary facing of the original anxiety will not be inhibited by secondary anxiety generated by the analyst.)

"Tell me?"

> (The conditions are thus made optimum—he is free to do whatever he wishes, but knows that any disclosures he may wish to make will be sympathetically received The opposite ['suppression'] would be to drive back the disclosures by generating additional anxiety, through ridicule or severity. ["That's enough of this nonsense, etc."] The whole illustrates the analytical commonplace that the analyst should

remain as nearly passive, friendly, encouraging, and neutral as possible)

"An ice team horsie bited me on my nose and putted his foot here [umbilicus], and it hurted awful much."

(The experienced and informed analyst has seen so much of fantasies and dreams of animals in a menacing rôle, and of cutting and biting, especially of noses, eyes, fingers, and—most importantly—penes, that it is not perhaps surprising that he succumbs to the universal human tendency to think of these phenomena as a standard group and to expect them to appear again in the same circumstances in which they appeared before, thus we arrive at that much ridiculed concept the "castration complex" The analyst, however, does not proceed by announcing this to the patient, unless the case is desperate and nothing else will produce any effect in the time he has at his disposal; to do so would be to run the grave risk of sacrificing his transference by any one of two or three routes An analyst who attempts to teach a system of psychology to his patient as a part of the analysis is of very doubtful competence The correct—that is, the fruitful and therapeutic—move is to hold the hypothesis to which experience inclines one in suspension and investigate the particular phenomena now in process)

"I wonder why?"

(The analyst does not suggest, in the crude sense [he does suggest, constantly, that there is something to look for and that it would help to look for it], he inquires)

"Because I tried to get some ice when the ice team stopped"

(A specific hypothesis of considerable probability has emerged The fundamental conflict arousing the anxiety is the classic hostility against the father and fear of reprisals ["Oedipus"], the specific occasion reactivating it is the desire to have the ice in the face of a parental prohibition, the horse [symbol of that part of the father which is purely fearsome] takes reprisal measures in the classic form The analyst tests as much of this as is practicable)

"Were you supposed not to have the ice?"

"Yes—it's naughty, Ronald [a friend] got some, and his mother spanked him"

(The spontaneous addition of similar material is definitely confirmatory of the interpretation The test having yielded positive results so far as it was applicable, the analyst now feels justified in disregarding the manifest content of the dream and dealing with the latent content, this is of course a leap in the dark, and errors are likely in estimating the point at which the evidence has become strong enough to warrant it The attitude should still remain tentative, in order to retrieve the

situation if it turns out that an error has been made, any injection of theory into the actual content of the interpretations would of course make this impossible)

"You know, there's nothing naughty about just having the ice, ice is good, if it's clean But sometimes big blocks of ice slip and fall down and hurt little boys when they climb on ice carts, and that's why we don't like to have you do it"

(If the interpretation is wrong, it is so phrased as to be approximately harmless, the worst it can do will be to function as an irrelevant injection into the main business of talking about the dream But if it is correct, it will operate to raise this incipient, irrational, "super-ego" bit of conscience from the sphere of unconscious inhibition and its reinforcing dread to full consciousness, where it can be handled by the ordinary logical reality methods by which well-adjusted adults handle their ethical problems It may or may not be extreme to suggest that an ice-cart phobia might grow out of this kind of beginning; but it seems very probable indeed that many phobias, including most importantly the all but universal sex phobia, have some such foundation)

"Oh Well, then, the next time I want some ice I can ask the man to get it for me."

(The interpretation was successful, the situation has been raised to consciousness and a logical solution found The anxiety has disappeared from the voice, and the child sighs, presumably with relief, and turns from his back to his side preparatory to going back to sleep The analyst praises his solution [as a part of the training plan above mentioned] and leaves him)

In summary of this microscopic but very illustrative bit of what, notwithstanding its informal setting, is truly representative of psychoanalysis, the following points may be emphasized

1. The analyst creates an atmosphere in which distress and discomfort of all irrelevant sorts is minimized, this makes it possible for the internal phenomena to be expressed with as little hindrance as, in the nature of the specific case, is possible In the adult patient this leads very naturally to transference; that is, the present situation having been reduced to as near neutral as possible, the patient begins to re-create situations from the past, and they may be expected to be affectively important situations involving persons, ordinarily the parents. Jastrow's remarks concerning transference are almost complete misunderstandings, which, it must be said, could have been expected to arise somewhere as a result of his attitude, quite explicit, that it is not necessary to make any direct observation of the phenomena under discussion, but only to read what has been postulated about them.

2 The analyst's activity is not suggestion in the sense of the implanting

of preconceived ideas, that is, it is not so in the best instances As Freud (2) has indicated in a section which is always cited wherever two or three are gathered together to laugh at psychoanalysis, one occasionally comes to a standstill in the use of purely passive methods, in such a case it may be desirable to adopt an active rôle rather than abandon the case as hopeless Hence it arises that in some circumstances it may be the wisest course available to tell the patient flatly what his symbolism probably means, in the hope of startling or antagonizing him into a somewhat "loosened" frame of mind The analyst does suggest, regularly, however, that there is something within the patient to be observed, that it will be valuable to him to observe and report upon it, and that it will be wise to suspend all ethical judgment for the time being Interpretation should, with the exception noted, be limited to inquiry, the more felicitous restatement of material already divulged by the patient, the pointing out of striking juxtapositions and unusual frequencies of special topics, the occasional framing of the various logical possibilities of a given situation, etc The confirmation of an interpretation is a critical point, and one that must be carefully regarded in the minute-by-minute planning of the analysis, the best confirmation is the immediate loosening of more material of the same sort, others are the "click," a "warm" inner conviction of appropriateness and connection (on the part of the patient), and (where the interpretation has been premature) a mobilizing of defensive forces, usually in the form of a counter-attack The best criterion of failure of interpretation is affective indifference, or sometimes faint annoyance and a return to the main stream of associations

3. The raising of unconscious material to consciousness, although a very real fact, is somewhat misleading when taken, as it often is, as a complete description of the analytic process A better description of the process is the realignment of motives, although probably no single phrase is completely satisfactory as a summarization of so complicated and obscure a set of phenomena, in the course of realignment it is likely that much unconscious material will be made conscious, but this is not necessarily the case, and instances have been known in which reasonably satisfactory results were obtained without the patient's knowing anything very specific about it An important aspect of raising to consciousness is that of the irrational conscience or "super-ego," illustrated in the dream reported, it is notorious that most of our social life is carried on with the sole guidance of purely emotional attachments and anxieties, and it is probably of enormous importance for our civilization that the power of rational decision in the light of facts be substituted for these to as large an extent as may be practicable.

It may be asked what, if this be representative of the factual material of psychoanalysis, becomes of the elaborate theoretical structure, to which, after all, most of the objections are made What inductions can be drawn about the Oedipus complex as usually stated, for example, from the material reported here? The answer, I think, is that the classical formulations must be

regarded as attempts to impose upon a very large body of data of the sort here reported (for the most part held in memory or in summary notes) some sort of coherence and organization Most of the disputation—among qualified disputants—appears to be about the adequacy of the formulations to account, approximately, for the data. It is possible to draw from a large number of observed instances, plus a knowledge of the formulations, helpful concepts as to the current mental content of the child described—helpful in the sense that tentative courses of action may be based upon them and presently tested as to adequacy It is not possible to draw from this instance anything definite about the Oedipus conflict, but it is quite possible to draw inferences of the form "Some children manifest anxiety with a content of injury by animals, apparently in reprisal for transgression of parental prohibitions" Further, a series of such cases may be supplemented by other series in which animals are definitely associated with the parents, and even by series in which animals which are consciously equated to parents are fantasied as menacing, to arrive at an inductive generalization (subject to all the hazards of any inductive generalization) that menacing animals in fantasies regularly represent parents There is, to be sure, a further link in the chain of proof, viz, the examination of the specific evidence in respectably large series and its adequate statistical evaluation, there seems little in the way of this except the lack of interest on the part of persons qualified to undertake it.

REFERENCES

1. JASTROW, J The house that Freud built New York Greenberg, 1932. Pp xx+293.

2 FREUD, S. General introduction to psychoanalysis. New York Boni & Liveright, 1920 Pp. x+406

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THE PROBLEM OF THE STABILITY OF THE HUMAN ORGANISM

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There is a close connection between the problem of the stability of the human organism and the problem of constitutional types An analysis of the formulas offered by psychologists, biologists, and clinicians for the definition of constitution convinces us of the presence of the connection of which we speak. In fact, great as the number of these definitions is, and indeed the number is no less than that of the authors themselves, yet at the bottom of these formulations there is always the premise of a certain complex of structural and functional features which, under a seeming mutability, preserve a definite qualitative sameness of tendency.

This stability finds its most categorical confirmation in Tandler's famous aphorism "Constitution is the somatical fatum of an individual", Bauer implies it also when, in his definition of constitution, he insists on the primacy of heredity, as he considers hereditary factors to be a guarantee of stability and durability Likewise, those who insist on the phenotypical character of constitutional distinctions do it for the reason that *phen* and *gen* are inseparable and that the influence of the environment may, in their opinion, impart to human organization a stamp just as lasting as heredity

The problem of stability of human organization is naturally bound up with that of changeability of constitution according to age The pediatrist, Salge, recognizes stability as a criterion of constitutionality He points out that "many conditions regarded as constitutional anomalies are nothing else than backward stages of development. In a great many cases these constitutional particularities disappear in early childhood so that at a later period no traces of these are apparent"

If those who claim the existence of conformity between age and constitution will consider the presence of complexes in accordance with the stage of development proper to the given period of life, then, indeed, insisting upon the presence of such complexes is like breaking through an open door But there are, if you like, biological peculiarities which are the constitution of the age and not the constitution of the child The fact that at an early period of life red corpuscles are greater in number, or that the pressure of blood is low, or that the body is original in its proportions, or that the voice at a certain period of evolution undergoes a change, or that the nervous system, especially the vegetative one, becomes unstable, the emotions unsteady, etc—none of these characterizes a given child or adolescent, and one could not foretell his or her further destiny upon the strength of these symptoms, because they are not individual, only the individual is constitutional

Our data relating to 40 human careers, of which we shall speak later on, testify to the fact that there is not a symptom, not excepting the individual conformation of the body, that would not, more or less, undergo the influence of age, but, in general, the tendencies proper to the dynamic development of a given individual remain relatively steady in their plasticity and trend

Kretschmer says the same thing, when, pondering the influence of age on constitution, he arrives at the following conclusion "Our investigations have taught us to beware of underrating the factors of age and surroundings and to study them carefully But a careful study actually shows that the foundations of constitutional gifts are changeable only to a certain degree, that they persist without suffering effacement from the influence of age, as strongly traced leading lines"

As a matter of fact, it is not fixed forms and functions that we have in view when considering the stability of human organization, for that

would ignore the factor of plasticity. The essence of the constitution, as Bondi aptly expresses it, consists not only in a plan of construction but in one of movement also; it is not only static but dynamic

The task that lies before us is to discover what traits are steady and stable, leaving open for the present the question of their origin What way shall we choose in order to solve this problem? Up to this time clinics have been chiefly relied upon to supply the material for the exploration of constitution But the clinic, to use Kretschmer's wording, gives a caricature of the norm, which, it seems to me, however expressive, cannot serve as a prototype of the norm, for it entails both quantitative and qualitative inexactnesses

Methods of investigation used up to the present time have served to bring about a better elucidation of the problem of constitution. But, supplementing these methods, another could be chosen, that of immediate, possibly objective investigation and observation of the whole life cycle of an individual through all the stages of its development amid the ordinary complications of human existence

I have undertaken to apply such a method, although I am quite aware of the imperfection of the results. I have undertaken to extract directly from the life history of 40 persons a body of consciencously ascertained facts, stated with sufficient exactness to elucidate the relative stability of psychophysical traits coming into evidence at an early age of development The data relating to these 40 human careers gathered by me are cited below

Only part of the collected material is taken from the sphere of my own personal observation. Out of the vast number of persons who have crossed my path, I have been able to include only four persons of whom I personally have sufficiently comprehensive observation. It is remarkable that other scientific workers[1] to whom I applied and who readily answered my call could furnish from the sphere of their immediate observation only single cases available for the purposes of my study Our feverish urban civilization brings every one in contact with a mass of people, both near and distant, but that same culture disperses those with whom we were once intimately familiar

I have taken precautions to make the results of my study trustworthy I was very careful both in the choice of observers and of subjects I excluded from my material, in the course of its elaboration, persons affected by chronic illnesses (syphilis and the like) and with serious physical defects, persons backward in their mental development, or such as have in the course of their life met with catastrophical disasters. Old age has been intentionally excluded from the sphere of investigation, though among the

[1]I feel bound to express my special thanks to Professor V V Gorineevsky, Professor V. P Kastshenko, Professor A A. Kissel, Dr R B Pevsner, Dr L K Schläger, and others

data in my possession there are cases in which investigation went up to its very beginning

Due to my fastidiousness in choice, the material assembled is rather meagre in volume, although a great deal of time has been devoted to the collection thereof The data in my possession concern 40 persons (mostly of the middle bourgeoisie and intelligentzia, only four of them belong to peasant and workers' families) at two life stages, namely, early childhood (5 to 8 years) and maturity (25 to 40 years). The following traits are considered growth, stature, degree of fleshiness (weight), state of physical health, motor activity, initiative, intellect (general endowments), special endowments (musical, mathematical, linguistic, artistic, literary-poetical, etc), emotional sphere, social attitude (sociability, friendship), character of social sphere, and, of the education received, the rate of development

The treatment of the data yielded results which in many points do not coincide with the conventional point of view In spite of the diversity of observers and of the subjects observed, it appears that certain traits of human organization over a space of 30 to 40 years preserved their stability to a higher degree than is generally admitted Another result which proved a surprise to the author himself was that growth, weight, physical health—all traits of somatic character—proved less stable than the more fluent and dynamic traits of a psychical and social nature

Table 1 summarizes (in percentages) the degree of stability of the traits of human organization covered by the data

The sign = signifies that the given trait of organization remains relatively unchanged, +, an increase, —, a decrease Consequently, in accordance with these conventional designations and the data submitted in the table, growth, for instance, with men in mature age, as compared with childhood (5 to 8 years), in 75% of the cases remained on a comparatively constant

TABLE 1

	Men			Women			General size		
Growth	=75	+15	—10	=77	+23		=76	+17	—7
Weight (flesh)	=77	—17	+ 6	=62 5	+25	—12 5	=73	+12	—15
Height	=58	+26	—16	=72	+14	—14	=62	+23	—15
Motor activity initiative	=80	+15	— 5	=77	—23		=80	+10	—10
Intellect	=72	+28		=75	+25		=70	+30	
Special endowment	=90	+10		=100			=92	+ 8	
Emotionality	=100			=67	—22	+11	=88	— 8	+ 4
Social attitudes	=94	+ 6		=78	+11	—11	=89	+ 7	— 4

TABLE 2

	Boys		Girls	
Health	+ 031	± 014	— 035	±.051
Social attitude				
Closeness	+ 054	±.015	+.028	± 015
Self-confidence	— 024	± 074		
Temperament	+ 015	± 014	— 013	± 014
Intellect	— 054	± 014	— 081	± 014
Handwriting	— 022	± 015	—.128	± 016

level, in 15% it increased considerably; in 10% it decreased Intellect, as compared with that of others of the same age, remained in 72% of cases on the same level; in 28% it rose, etc

The data submitted are in general accord with the results obtained by K Pearson with whose work I became acquainted only after I had made a communication at a congress on the study of human behavior K. Pearson, on the basis of notes taken through the medium of school teachers on 4000 children of various ages (4 to 19 years), showed by means of an exemplary statistical treatment, that age is not correlated with the dynamics of development of a whole series of psychical and physical traits.

In Table 2 are presented the coefficients of correlation secured by Pearson (5):

Thus, Pearson having in his possession an enormous mass of data and using an entirely different method of analysis arrives at conclusions far more extreme than those drawn from the facts we have ourselves collected.

The other conclusion derived from our table, the one concerning the relative unstableness of the somatical insignias which consequently cannot be much relied upon in the way of definition of constitution in early childhood, has been arrived at by other authors also (Brugsh, Weidenreich, and others)

Our basic conclusion concerning the considerable stability of dynamic development of given features of human organization, combined with an extreme mutability of forms of conduct, is in conformity with the facts stated in quite a different field of investigation, namely, the study of the history and development of monozygotic twins

The American child psychologist, Arnold Gesell, who has devoted a special monograph (2, 3) to this subject, cites several cases in which repeated examinations through a series of years of both physical and psychic traits of twins yielded evidence of a striking resemblance This stability of structure in monozygotic twins finds its expression, as some investigators state, in the pathological phenomena also

Lange reports a case of two 80-year-old women twins whose ways in

life were quite different and who fell mentally ill on the same day. With both the disease took the same form and a similar course and ended in a complete recovery on the very same day. Another similar case has been communicated to us by Negeli (4) He happened to tend at the same time twin brothers (monozygotic twins) who were ill of an inflammation of the lungs which took with both an identical form and course

I cannot dwell here on these facts There is no doubt that the problem of twins deserves far more attention than has been paid it hitherto (1). The results of twin research provide us with valuable indications that an extreme plasticity of human organization can be combined with great stability In discussing such facts, investigators address themselves to the problem of nature versus nurture What is more important to us here is to establish which complexes in human organization at a given age and under the reciprocal influence of both internal and external factors of development permeating one another are relatively stable in their dynamic expression.

The stability of separate traits in the cases we have collected varies within the limits of a rather large scale, between 50 and 100% If we begin with middle figures for both sexes, we shall have in the ascending order, i e, in the order of gradual increase of stability the following array health, weight (degree of fleshiness), intellect (general endowments), stature, motor activity and initiative, emotionality, social attitude, special endowments

Thus, motor activity and initiative, emotionality and social attitude are the traits which form the most immutable framework in the development of our individuals

It is interesting to note that, in our cases, the intellect behaved like the IQ in a series of investigations by American authors on the one hand, it proved in most cases very stable in respect to influences of social factors, on the other hand, in a quarter of the cases it displayed a tendency to rise with age

Sex did not particularly affect the degree of stability of the different aspects of organization Under separate rubrics for men and women we find not only approaching but even coinciding figures (e g, growth, intellect, health, special endowments) Yet, on some aspects sex has put its stamp, most notably in the emotional sphere where the fate of men and women proved very different While with all men the character of emotionality which appeared in childhood preserved its basic characteristics through the decades, with women in one-third of the cases it changed, mostly tending to decrease The analysis of the data in our possession shows that marriage plays here the decisive part Married life and domestic cares caused a great change in the emotional sphere of women and in most cases narrowed it and overwhelmed it

The same trend, though in less degree, is applicable to motor activity

and to initiative. Though the percentage of stability with both sexes corresponds, yet the number of cases in which this form of activity lowered is three times larger with women than with men

Without entering into details, we may sum up the influence of sex on the degree of stability of different aspects of organization, according to the results drawn from our material, as follows with men the age of maturity in comparison with the preschool age is marked with considerable change in the state of health, often of decline, in many cases with relative decrease of weight and rise of initiative and intellect, with women the health proved more stable, stoutness had a tendency to increase, motor activity, initiative, and emotionality abated in many cases In other respects sex did not exercise any great influence on the stability.

Of the rate of development of separate individuals we have but scanty information in our material Only in two cases this rate, both according to the supplied data and to the evaluation of the observers, must be considered as exceptional

In the one case we have undoubtedly to do with an accelerated rate of development a descendant of a rich bourgeoise family evinced at an early age (7 to 8 years) certain exceptional gifts of memory, capacity for concentrated work, and musical talent Early (at the age of 15 to 16 years) he began sexual life, evidenced in his social attitude and physical development (pycnic type) From his very childhood and up to his premature death, this individual amazed his associates by his vast capacity for work, brightness of spirit and an extreme suppleness of his organization.

Another case may be termed a saltatory form of development In this case the child was born in a family of ragamuffin proletarians The father was a rascal and a drunkard, the mother a huckstress—seller of stolen things. This boy grew physically weak, a retiring creature, who, among the boys of his own age, was an object of derision. Later on he fled from his family and got into a different circle, passed through the test of civil war and became an altered man, physically strengthened, and now, at the age of 27, he is in good health; his stature is erect; his intellect not a bit below the average; he occupies a responsible post

The rate of development undoubtedly has a great importance in the construction of an individual career But of still greater importance for the understanding of an individual is the degree of stability, not of his separate traits, but of his total organization From this point of view all the individuals in our group fall into two distinct types; the stable and the unstable (labile). Persons of the first type, to which the majority belonged, passed through life preserving the biological tendencies of their early childhood relatively intact. It would be wrong to suppose, however, that the stable type assumes the same forms at different periods of existence On the contrary, plasticity and changeability of outward forms of life

activity are not only compatible with the general stability of type, but very often it is just this plasticity which forms the most prominent and steady trait of the organization I cite as an illustration the following case from our records

In childhood (6 to 8 years) of middle stature, with short legs, a full-bodied, blooming, active boy, with lively mimicry, well-coordinated movements, very sociable, rather timid and effeminate, with an intellect above his age, with a capacity for music, very assiduous at work, inconstant in his humors, and emotions, but generally bright, religious, more in the sense of inclination toward religious ceremonies and scripture

As a youth he preserves his outward appearance, matures early physically, makes good progress in his studies at school, has large connections in different parts of society, easily and suddenly abandons his religious disposition, begins sexual life early

At the age of maturity, blooming and healthy, rather fat, with a clearly expressed pycnic body build, a rather well-known political character, an orator rather out of the common, popularizer and propagandist, reaping success both among the bourgeoisie and the proletarians, well read in Marxist literature, always bright and noisy, strikingly clever at work For tens of years he showed an extraordinary suppleness and adaptability and remained practically all the time unchanged, notwithstanding the great changes about him, which provoked on his part the most varied, sometimes contrasting, forms of behavior which puzzled the persons who knew him

In many respects, contrasting this clearly expressed pycnic type, yet approaching him in stability of organization, is another individual whom we have observed from 4 to 35 years of age

In early years of life the boy, only son of intelligent parents, of a delicate asthenic constitution, below average size, with a narrow chest and large head, with clearly expressed neuropathic propensities, evinced a great spirit of observation, a capacity for steady application, a richness and expressiveness of speech, a great fund of knowledge, an excellent memory, motor endowments, a strong imitativeness, an inclination to reasoning Obstinate, insisting, even rude with regard to his familiars, he evinced timidity and a painful confusion in the presence of strangers An excessive bashfulness developed in him at an early age In his school years he learned readily, took the leadership over his comrades, but was intimate with none

Ambitious and vain, easily influenced, the organizer of all kinds of boys' activities (plays, clubs, protest movements, magazines, etc) he easily mastered all sorts of sports, but none had particular attraction for him He early displayed a quick perception of rhythm

Sickly at the age of adolescence which was marked by intense growth, he attained maturity both in physique and in character a clearly expressed cyclothymic in whom a subtle and sickly sensibility was associated with

emotional dullness, aesthetic tendencies, and exquisiteness of manner—with rudeness, naivety, and childishness of some impulses—with a complete absence of sincerity and with indifference to nature; with weakness of will and suspiciousness, perseverance in the attainment of his aims, timidity, with self-confidence, veneration for decadents, and with a cold serenity of mind

Thanks to a great capacity for organization and an exceptional memory, he attained a high place among the new generation of linguists

The labile type is represented in our collection more rarely and less distinctly Changes in the conditions of life, illnesses, even though not very serious and prolonged ones, obstacles met on the way of life, or, on the other hand, success, an important event like marriage, or loss of a friend or a near relation, etc, cause changes both in the mental and physical spheres

Stability and lability of organization are, of course, only relative notions, since, after all, both stability and lability are only different forms of the basic adaptability of the human organism It would be very interesting to trace which complexes of traits show the greater tendency to stability in the struggle of life, but to these questions, as to others, our data do not give conclusive answer

References

1 ARKIN, E Personality and social sphere (3rd ed)
2 GESELL, A. L Mental and physical correspondence in twins *Scient Mo* 1922, 14, 305-344
3. ——— The mental growth of the preschool child New York: Macmillan, 1925 Pp 447.
4. NEGELI, — General study of constitution
5. PEARSON, K On the relationship of health to the psychical and physical characters of school children New York Columbia Univ Press, 1923 Pp 77

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A STUDY OF THE VARIATION IN IQ OF A GROUP OF DEPENDENT CHILDREN IN INSTITUTION AND FOSTER HOME

DONAH B LITHAUER AND OTTO KLINEBERG

In Part I of the *Twenty-Seventh Yearbook of the National Society for the Study of Education*, Chapter IX, Sections I and II, Freeman reported a study of 74 children who were given the Stanford-Binet test before and after placement in foster homes. The purpose of this paper is to present additional data on the influence of change of environment on the Binet scores

TABLE 1

RANGE OF CHRONOLOGICAL AGES

First Test		Retest	
Range	3-3 to 13-10	Range	5-1 to 15-0
Mean age	6 years 6 7 months	Mean age	8 years 1 month
Median	6 years 0 9 month	Median	7 years 2 9 months
Q_1	5 years 2 7 months	Q_1	6 years 5 7 months
Q_3	7 years 5 5 months	Q_3	8 years 8 7 months
N	120	N	120

The subjects were 120 children under the care of the Hebrew Orphan Asylum, New York City. The children were all examined shortly after admission to the Reception House and were reexamined after a period ranging from a few months to several years Table 1 gives the range of chronological ages at the first test and at retest The mean IQ on the first test was 82 29

The children were retested for various reasons

1 Children of preschool age at first test were retested at approximately age 6 for placement in school

2. Children of school age at first test, but kept out of school because of low mental age, were retested for further guidance

3 Children having difficulty with school work were retested for the purpose of adjustment (with the aid of achievement tests).

4 Children in special classes (ungraded and opportunity) were reexamined to determine the possibility of promotion.

5 Children in junior high school were retested for further guidance if there was doubt regarding their future course of study—high school or trade training

Statements 2, 3, and 4 explain why the mean IQ on the first test is only 82 29, while the mean IQ of the whole orphan aslyum population, including children in foster homes, is 94 01 (latest figures based on 1195 cases) All the children who had been retested were included in this study except (1) those who were not examined by the present psychologist or her assistants, (2) those first tested several weeks after admission, and (3) those with a marked foreign-language handicap

PREVIOUS AND PRESENT ENVIRONMENT

The Hebrew Orphan Asylum is an institution for the care of dependent children The children are admitted to the Reception House and, after the necessary physical and mental examinations, are transferred to the institution proper (which houses about 850 children) or are placed in foster homes Although it was impossible to make a detailed study of the environment before and after the test, these general statements may be made:

Previous Environment Children are admitted for the following reasons: illness or death of one or both parents, separation or divorce of parents, or desertion; improper guardianship leading to the child's commitment to the institution as a "neglected" child, inability on the part of the parents to control the child; poverty.

Present Environment. Both in the institution and in the boarding homes, the children live in a more stable environment, attend school regularly, receive ample food, clothing, sleep, and recreation, enjoy a greater variety of experiences, and are under the care of councilors or foster mothers who are superior, on the average, to the children's own parents This obviously does not mean that the children are now living under ideal socio-economic conditions, but simply that there has been an improvement over their former environment. The foster homes are supervised regularly by trained social workers, and the children both in the institution and in the boarding homes are referred for special guidance to the psychiatrist and the psychologist

The institution children and the foster-home children are not considered separately in this study The 120 cases are about equally divided between the two groups and a rough calculation of the results of the retests shows similar changes

The Stanford Revision of the Binet-Simon Scale was used. All tests were administered by one psychologist and her two assistants, who worked under her supervision and whom she personally trained It is believed that the personality of the examiners can be practically eliminated as a factor influencing the results.

As stated above, the 120 children were examined shortly after admission to the Reception House and were reexamined after a period ranging from 3 months to 57 months.

Results

Table 2 shows the distribution of IQ's in the first and second tests The correlation between the first test and the second test is $+.76 \pm .03$ The difference between the means is 5.96, which is more than 10 times its probable error of $\pm .586$ (based on the formula for the reliability of the difference between correlated means)

Table 3 shows the distribution of changes in IQ. The changes range from -17 to $+30$ There are 89 increase changes, 27 decrease changes, and 4 zero changes The mean change is $+5.9$ (based on the actual distribution of the changes, ungrouped, and not on the difference between the means of the first and second tests) The middle 50% of the changes for the entire group falls between -0.3 and $+11.8$ The limits of the middle 50% for 435 cases reported by Terman on page 142 of *The Intelligence of School Children* are -3.3 to $+5.7$

Tables 4 and 5 show a marked relationship between change in IQ and

TABLE 2

DISTRIBUTION OF IQ's

IQ	First test *F*	Retest *F*
135-139	1	0
130-134	0	1
125-129	0	0
120-124	1	2
115-119	1	0
110-114	1	5
105-109	3	5
100-104	3	13
95- 99	6	11
90- 94	11	12
85- 89	23	19
80- 84	18	17
75- 79	14	14
70- 74	17	12
65- 69	9	5
60- 64	8	3
55- 59	4	0
50- 54	0	1
	N 120	*N* 120
	Range 55 to 138 Sigma 13.73 Mean 82 29± 84	Range 53 to 130 Sigma 13 99 Mean 88 25± 86

TABLE 3

DISTRIBUTION OF CHANGES IN IQ, COMPARING SECOND WITH FIRST TEST

Change	F
+28—32	1
+23—27	3
+18—22	11
+13—17	8
+ 8—12	28
+ 3— 7	27
— 2+ 2	18
— 7— 3	14
—12— 8	7
—17—13	3
	N 120

Range —17 to +30
Mean (measures ungrouped) +5 9

(1) age at first test and (2) age at retest The younger the child at the first test and the younger the child at the retest, the greater the increase in IQ It is interesting to note that 13 of the 27 minus signs fall in the group aged 8 years and above at the first test, where the number of cases is only 24

The relationship between changes in IQ and ages at first test and at retest is also expressed by the correlations tabulated in Table 6 The correlation of change in IQ with age at first test is —42± 05 and with age at second

TABLE 4
RELATION BETWEEN CHANGES IN IQ AND AGE AT FIRST TEST

N	Age range	Changes in IQ Median	Q_1	Q_3
120	(entire group) 3-3 to 13-10	+6 3	—0 3	+11 8
85	6 years and below	+8 5	+2 7	+13 5
96	7 years and below	+7 9	+2 1	+12 6
24	8 years and above	—2.6	—6 4	+ 5 5

TABLE 5
RELATION BETWEEN CHANGES IN IQ AND AGE AT RETEST

N	Age range	Changes in IQ Median	Q_1	Q_3
120	(entire group) 5-1 to 15-0	+6 3	—0 3	+11 8
82	7 years and below	+8 7	+3 1	+13 9
38	8 years and above	0	—5.75	+ 6 6

TABLE 6
INTERCORRELATIONS

Zero-order coefficients		Partial correlations	
IQ first test with IQ retest	r=+ 76± 03		
Age at first test with change in IQ	r=— 42± 05	Lapse of time constant	r=— 40± 05
Age at retest with change in IQ	r=— 39±.05	Lapse of time constant	r=— 38±.05
Lapse of time with change in IQ	r=— 16± 06	Age at first test constant	r=— 08± 06
		Age of retest constant	r=+ 11± 06

test, $-.39 \pm .05$. Partialling out the time elapsing between tests has little effect on the correlations. The mean time which elapsed between tests was 18.92 months, median 14.8 months, lower quartile 8.9 months, and upper quartile 25.5 months, range 3-57 months.

Probably the most interesting coefficient in connection with our problem is that representing the relationship between lapse of time and change in IQ (Table 6), for it indicates a lack of significant correlation between the two variables, even when the ages at first test or ages at retest are held constant. In Freeman's study the retests were given to the entire group of children after several years of residence in the foster home. Our results suggest that Freeman might have found approximately as large an increase in IQ if the children had been in their new homes for a much shorter period, although the fact that his children were older than those reported in this study introduces a complicating factor.

Conclusions

Our data would seem to warrant the following conclusions:

1. Improvement in environment apparently has a favorable influence on the IQ. The mean improvement for the entire group is 5.9 and the median is 6.3 points in IQ. It is unlikely that this increase is due to practice effect, as the time elapsing between tests ranges from 3 months to 57 months and there is a lack of correlation between change in IQ and lapse of time. If practice effect were an important factor we should expect that those retested after a few months would improve much more than those retested after a few years. In addition, when we rule out the possibility of a practice effect by excluding those cases in which less than 11 months have elapsed between the two tests, the remaining group of 76 children likewise shows a mean improvement of 5.9 points. It seems reasonable to conclude, therefore, that the difference demonstrated in this study cannot be explained as a practice effect but can be considered a true difference.

2. It is probable that the change in IQ reported in this study (approximately 6 points) does not adequately represent the average improvement which may result from a marked change in environment. The "superior" environments in which the children are now living would in many cases not rank very high on any objective social and economic rating scale, and could not therefore be expected to affect the Binet scores to more than a moderate degree.

3. The negative correlation between age at first test and change in IQ may be interpreted in either of two ways:

   a. The environment has a greater influence on the child during the earlier formative period.

   b. Defects in the Binet scale itself are responsible for the greater increase at the younger ages. (A study of the distribution of IQ's for 905 children aged 5 to 14 years, as reported by Terman in *The Stanford Revi-*

sion and Extension of the Binet-Simon Scale for Measuring Intelligence, reveals a drop in IQ with age. On pages 33 to 38 graphs are presented which show the median IQ's decreasing from 102 and 103 at ages 5 and 6, respectively, to 96 5 and 97+ at ages 13 and 14, respectively) It is probable that *both* factors contribute to the final result

4 The lack of significant correlation between change in IQ and lapse of time suggests that a few months in an improved environment may suffice to produce a marked increase in IQ

5 *Clinical implications* The marked variations in IQ as a result of retesting should be a warning to clinical psychologists to interpret test results cautiously, to give supplementary tests whenever possible before making recommendations, and to make frequent reexaminations when there is any reason to believe that the child did not work up to his capacity on the first test, or that he was unduly handicapped by a poor environment

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THE INFLUENCE OF AGE UPON LEARNING AND RETENTION OF POETRY AND NONSENSE SYLLABLES

J. B Stroud and Ruth Maul

Introduction

The purpose of this study is to determine the influence of age upon the memorization and retention of poetry and nonsense syllables in the case of 226 subjects This is the first of two studies upon the general problem of the relation of age to acquisition and retention In the present study, all age groups learned the same material In a subsequent study, an attempt will be made to grade the material upon the basis of difficulty of comprehension, so that the material for any age group will be of the same relative difficulty as that used for any other age group.

In this study the following specific questions are studied. (1) The relation of CA to learning poetry and syllables; (2) the relation of MA to learning poetry and syllables, (3) the relation between IQ and poetry and syllable scores for the successive age groups, and (4) the relation of age to retention of poetry and syllables.

Procedure

The subjects comprise 172 grade-school children ranging in age from 7-11, 26 ninth-grade students with an average age of 14, and 28 college freshmen with an average age of 18 The grade-school children constitute the major part of the enrollment between Grades 2-6 inclusive of the Training School of the Kansas State Teachers College

The memory material consisted of three poems, four lines to the stanza, and six lists of three-letter nonsense syllables. The poems and syllables were written in primer type for the grade-school subjects. Conventional type was used for the other subjects The poetry was well within the interest and comprehension of even the youngest subjects[1]

An effort was made to control coaching by alternating the three poems and six lists of syllables In the case of the school children, the subjects for any day's experimentation were selected at random from their respective half-grade rooms The rooms from which the subjects were taken for any day's work were also selected at random The experiments were conducted individually in the clinic testing rooms The atmosphere was one of a mental test, to which the children were used, rather than that of an experiment

The subjects were allowed 15 minutes for learning poetry and 10 minutes for learning the syllables The scores consisted of the number of lines and syllables learned within the time limits The subjects were available for only one class-period of 30 minutes The temporal order of presentation of poetry and syllables was alternated, on the grounds that the younger subjects might become fatigued earlier than the older subjects Should this be true, and should one type of material be uniformly presented last, the younger subjects would appear to be at a relative disadvantage in this material

The progressive part method was used in learning The whole method was used in relearning Presentation and recall were alternated The material, presented visually, was read aloud by the subject

The syllables and poetry were written upon 9 x 11 paper The syllables were written in a single column Two syllables constituted a unit for the progressive part procedure The syllables were spelled out in presentation and recall The complete exposure method was used for presentation

All subjects were tested for retention one week after learning The relearning method was used Saving scores were computed The 7-, 9-, and 11-year groups were given a second retention test approximately six weeks after the first

Saving scores were computed in trials only The reader will recall that the progressive part method was used in learning Of course the subject learned stanzas 1 and 2, for example, as independent units and then integrated the two separate units Next he learned stanza 3 as a unit and then integrated the three units, and so on until time was called. The largest number of units completely integrated was taken as the basis for relearning Relearning was 100% The saving score represents the ratio between the number of trials required to learn the stanza units completed

[1]The poetry was written for the experiment by Dr Norman Triplett, author of *Nursery Rhymes*

by a subject and the number of trials required to relearn the same stanza units There is naturally a certain source of error in the procedure from the standpoint of retention Many subjects were working upon the integration of additional units when time was called and consequently had some overlearning upon the units just completed Investigation of the individual score sheets showed that this error was practically constant for the comparative age groups

All subjects were given the Kuhlmann-Anderson Group Intelligence Test.

Results and Discussion

The relation between CA and the respective mean scores is shown in Table 1. The average IQ of each age group is given for comparative purposes

TABLE 1

The Relation of Age to Poetry and Syllable Scores

Av. CA	Av. IQ	Poetry	Syllables
7 7	115	9.71± 54	4 73± 19
8 5	115	11 16± 43	5 12± 21
9 4	115	13 15± 47	5 82± 23
10 4	111	16 02± 56	6 43± 24
11.7	103	17.55± 65	6 74± 24
14 4 (9th grade)	109	21.31± 89	7 39± 30
18.1 (freshmen)	114	22 14±.65	8 71± 39

Inspection of the foregoing table, as well as of Figures 1 and 2, reveals a definite and somewhat regular increase in performance up to age 11, and a more gradual increase thereafter. The reader's attention is called to the fact that there are no cases between 11 and 14 and none between 14 and 18 Consequently, the upper portion of the curves is to be regarded with more skepticism than the lower portion

The curves in Figures 1 and 2 exhibit some of the initial characteristics of S-curves Although the point is not urged upon the basis of these data, it is reasonable to suppose that growth curves of such functions would necessarily be S-shaped should one begin with a sufficiently early age Obviously, no lines or syllables would be learned by the average child at the end of the first year within the time limits imposed in this experiment The number learned at the end of the second year would be extremely small The number learned by the successive age groups should increase at an increasing rate for a time It is probable that the upper portion of the positive acceleration has been attained in the case of the lower age levels of this study These suppositions conform to certain other growth functions, such as vocabulary development and reading

The *P.E* of the differences between the adjacent age groups is in some

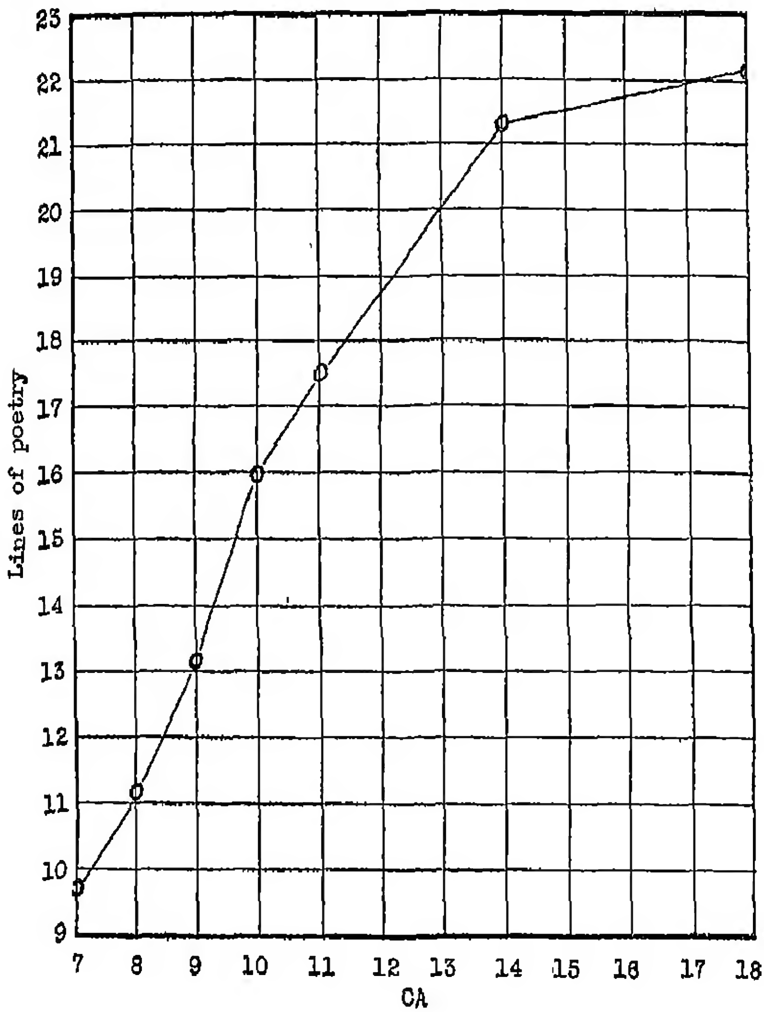

FIGURE 1
RELATION OF AGE TO MEMORIZING POETRY

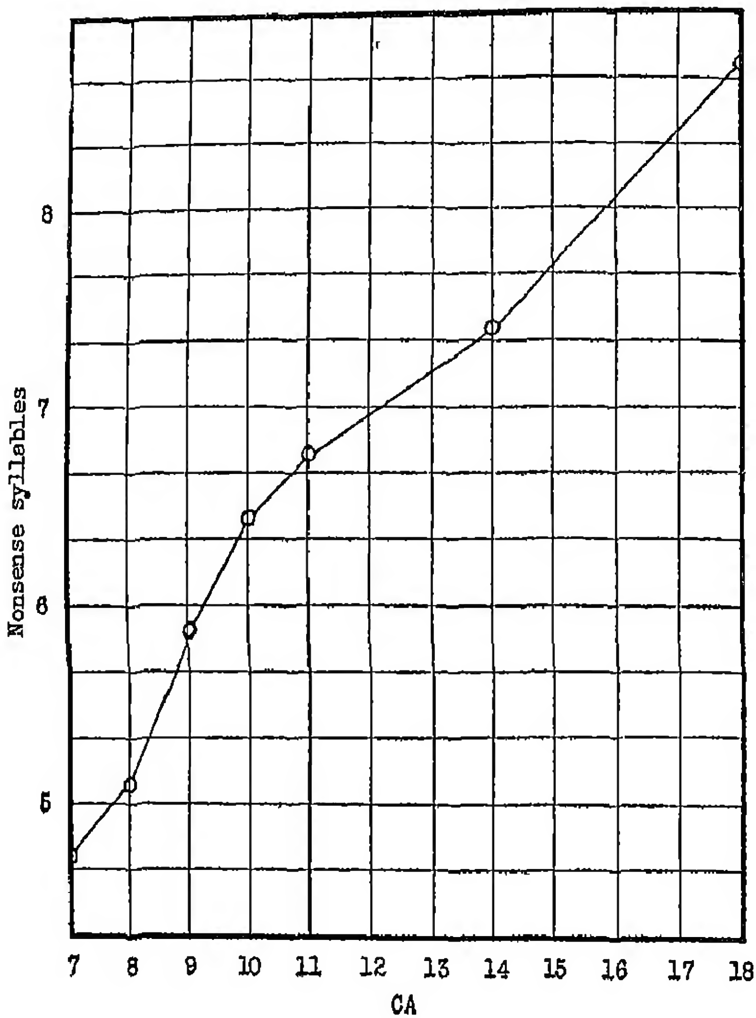

FIGURE 2
RELATION OF AGE TO MEMORIZING NONSENSE SYLLABLES

TABLE 2

CORRELATIONS

Variables	Correlations
CA and poetry scores	61± 028
CA and syllable scores	49± 034
MA and poetry scores	67±.024
MA and syllable scores	61± 028
MA and CA	90± 008

cases as large as the differences However, when age groups separated by one, two, three, and more years are considered, the differences become increasingly larger than the *P.E* of the differences Between the more extreme age groups the differences are 4-9 times their *P E*'s Furthermore, the probability of selecting seven age groups, with from 25-40 subjects in a group, whose scores on two kinds of materials would, without exception, increase somewhat definitely and regularly, purely by chance, is exceedingly small The significance of the consistency of the obtained differences is further emphasized by the relatively short learning time employed

The relation between age and the learning scores is further demonstrated by the correlation technique The results are contained in Table 2

These correlations are regarded as rather significant in view of the relatively short time intervals allowed for learning The reliability of the scores is probably not a great deal higher than the coefficients obtained between the scores and MA The correlation between the poetry and syllable scores is 64± 027

It seemed probable that there might be a large spurious factor in the correlations involving CA and MA An attempt was made to control this by the use of the partial correlation coefficient

Table 3 contains the results The partial correlation coefficients indicate that CA is relatively unimportant An attempt was made to verify this in tabular procedure by holding MA constant and varying CA The average grade of each group was determined for comparative purposes Table

TABLE 3

PARTIAL CORRELATIONS

Variables	Correlations
1=MA	r_{13} = 35
2=CA	$r_{14\,2}$ = 45
3=Poetry scores	$r_{23\,1}$ = 03
4=Syllable scores	$r_{24\,1}$ = —02

TABLE 4

SCORES OF GROUPS OF SUBJECTS WITH THE SAME MA BUT DIFFERENT CA

MA	CA	*N*	Poetry	Syllables	Av grade
9	7	12	12 50	5 33	3.0
9	8	10	11 20	4 80	3 5
9	9	4	12 75	7 00	3 9
10	8	9	11.44	6 11	3 5
10	9	16	11 25	5 06	4 2
10	10	9	14 89	6 33	5 4
11	9	13	16 53	6 38	4 6
11	10	17	16 82	6 23	5 4
11	11	9	17 44	7 11	6 0

TABLE 5

RELATION OF GRADE PLACEMENT TO LEARNING SCORES

Av MA	Av CA	Grade	*N*	Poetry	Syllables
8 6	7 5	2B	11	7 18	3 91
8 8	7 6	2A	9	10 22	4.55
9 7	7 7	3B	9	11 66	5 22
9 8	8.5	3A	8	10 75	5 25
10 4	8 5	3B	6	12 50	5 50
10 5	9 0	3A	10	11 10	5 20
10 7	9 3	4B-A	10	13 00	5 80
10 7	10.7	5B-A	9	18 00	6 11
11 4	9 4	4B	5	17 20	6 60
11 4	9 6	4A	8	16.50	6 75
11 8	10 3	5B	11	16 18	6 18
11 7	10 9	5A	7	18 43	6 29
11 8	11 4	6B	7	19 14	7 14

4 contains the calculations The results fail to indicate any clear tendency for the scores to vary with CA when MA is constant They are in general agreement with the partial correlation coefficients It is also to be noted that grade placement varies somewhat uniformly with CA

On the basis of the data in Table 4, the effect of grade placement upon the scores is not altogether clear. The indication is that it is not particularly significant An attempt was made to verify this by comparing the scores of subjects in different grades when MA is relatively constant and CA is known. The results are given in Table 5 These results seem to show

that a difference of one to four half-grades is not a significant factor when MA is constant The differences observable in Table 5 are within the bounds of chance There are as many cases in which subjects of a higher grade make lower scores than those of a lower grade but of the same MA as there are cases in which they make higher scores

Finally, it seemed worth-while to compute the correlation between IQ and scores for each separate age group. The results are found in Table 6 The correlations between IQ and poetry scores are rather uniform but low. Those between IQ and syllable scores are very unstable and not statistically significant. There is no tendency for the correlations between IQ and either type of material to increase or decrease with age

As mentioned earlier, all subjects relearned the material one week after learning Saving scores computed for each age group are given in Table 7 The saving scores show no tendency to increase or decrease with age The subjects of the 7-, 9-, and 11-year groups relearned the material a second time, approximately six weeks after the first relearning The saving scores again show no tendency to increase or decrease with age These scores for poetry are .66, 70, and .67 for the respective age groups, for syllables they are 31, 46, and 42, respectively

The saving scores were found to be highly variable throughout It is not known whether retention is a highly variable trait or whether the saving scores obtained have a low degree of reliability

TABLE 6

CORRELATION BETWEEN IQ AND SCORES

CA	$r_{\text{IQ poetry}}$	$r_{\text{IQ syllables}}$
7	46± 090	.06±.115
8	46± 106	44± 108
9	42± 091	03± 113
10	32± 190	29± 095
11	58± 079	27± 111

TABLE 7

SAVING SCORES FOR RESPECTIVE AGE GROUPS

CA	Saving scores Poetry	Syllables
7	69	.42
8	68	33
9	65	51
10	71	52
11	64	40
14	76	60
18	75	56

Conclusions

1 Within the limits of this study, learning scores for poetry and nonsense syllables increase with age

2 The relation between chronological age and scores is largely spurious

3. The relation between mental age and poetry and syllable scores is high and statistically significant.

4 This study reveals no relation between age and retention as measured by saving scores

Bibliography

1 Gould, M A, & Perrin, F A C A comparison of factors involved in maze learning of human adults and children *J Exper Psychol*, 1916, 1, 122-154

2 Henderson, E. C A study of memory for connected trains of thought *Psychol. Rev, Monog Suppl.*, 1903, 5, No 23 Pp iv + 94

3 Lyon, D O The relation of quickness of learning to retentiveness *Arch Psychol*, 1916, No 34 Pp. 60

4 McGeoch, J A The influence of sex and age upon the ability to report *Amer. J. Psychol*, 1928, 40, 458-466

5 Peterson, J. Experiments in rational learning *Psychol. Rev*, 1918, 25, 443-467

6 ——— Learning in children Chap 10 in *A handbook of child psychology*, ed. by C Murchison Worcester, Mass Clark Univ Press, London Oxford Univ Press, 1931 Pp. 316-376

7 Shaw, J A A test of memory in school children. *Ped Sem.*, 1896, 4, 61-78.

8 Thorndike, E L, *et al* Adult learning. New York Macmillan, 1928 Pp x + 335

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A STUDY OF CERTAIN SELECTIVE FACTORS INFLUENCING PREDICTION OF THE MENTAL STATUS OF ADOPTED CHILDREN—ERRATUM

Alice M. Leahy

In line 5 on page 311 of Volume 41 (December, 1932) of this journal the word "tests" should be inserted after "intelligence," making the sentence read as follows Haggerty and Nash (12), in a study of 8121 New York State school children in Grades 3-12 inclusive, found that success in intelligence tests is directly related to the occupation of the fathers

BOOKS

C J WARDEN *The Evolution of Human Behavior* New York: Macmillan, 1932 Pp ix+248 $3.00

This book purports to be a new approach to the problems of evolution The author claims that "Most of the books that have appeared in this field up to the present have dealt almost exclusively with the evolution of man's bodily structure . . In the present volume, behavior rather than bodily structure has been stressed The writer believes that the evolution of human intelligence, with its almost limitless capacity for cultural development, should be regarded as the central theme of the general problem" Nevertheless, one finds in this book a rather conventional and popularized presentation of some of the literature on cultural and structural anthropology The author's references are from secondary sources Despite the fact that this book purports to deal with the evolution of behavior, one finds no reference to the extensive data of comparative psychology There is but brief reference to the data on racial intelligence The greater part of the book stresses structural and cultural data

The opening chapter deals with the value and meaning of evolution, trends in evolution, and theories concerning the origin of species The second chapter discusses the natural kinship of man and animal In this chapter the author misses an excellent opportunity of pointing out the behavioral capacities of different animal forms and the similarities which indicate the process of psychological as well as structural evolution However, the data are the usual structural ones stressed by every other writer in the field The third chapter, dealing with the transition from ape to human, is similarly lacking in psychological data There is a brief discussion of the evolution of language, but no mention of the evolution of the symbolic process which made it possible Such data as those on the delayed reaction and the double alternation response, which seem rather clearly to indicate the evolution of symbolizing ability from lower animals to the primates, are entirely lacking There is likewise no mention of the important researches of Hobhouse, Kohler, Yerkes, and others on the behavior of apes A chapter on the traces of early man deals with eolithic and early paleolithic life and culture The culture of *Homo sapiens* is discussed in a further chapter This chapter is illustrated with numerous pictures of weapons, drawings, architecture, and the like In the chapter on racial characteristics one finds brief mention of the data on racial differences in intelligence The author believes that these differences are primarily cultural In his final chapter, which concerns present trends in evolution, the author discusses eugenics and human progress. He says, "On the whole, the forces of evolution are so manifold and inscru-

table that it is useless to attempt to predict the course of human evolution that lies ahead But if the direction of evolution cannot be predicted then surely the question of human welfare and human progress must be left to the future"

Although this book does not exactly do what it purports to do, it should prove interesting to those who wish a rather concise review of recent findings and opinions in the field of structural and cultural anthropology

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BOOKS RECEIVED

ALLPORT, G. W, & VERNON, P E Studies in expressive movement New York Macmillan, 1933. Pp xiv+269 $3 00

FIELDS, P E. Studies in concept formation *Comp Psychol Monog.*, 1932, 9, No. 42. Pp 70 $1.25

FRANZ, S I., & GORDON, K Psychology work book New York & London: McGraw-Hill, 1932 Pp. x+227 $1 25

GREENE, H. A. A criterion for the course of study in the mechanics of written composition. *Univ. Iowa Stud · Stud Educ*, 1933, 8, No 4 (New Ser., No 246) Pp 64

HOLLINGWORTH, H L Educational psychology New York· Appleton, 1933. Pp xvi+540 $3 00.

JONES, E. S. Comprehensive examinations in American Colleges New York: Macmillan, 1933. Pp xx+436. $2 50

KLEIN, M. The psycho-analysis of children. (Trans by A Strachey) New York Norton, 1932. Pp 393

PINTNER, R Pintner Intelligence Test for Grades IV to VIII—Form A and Form B New York· Bur Publ., Teach. Coll., Columbia Univ, 1932 Pp 39.

POPP, W Milieu und Selbstbestimmung. (*Mann's päd Mag*, No 1295) Langensalza: Beyer & Söhne, 1930. Pp viii+166 4,30 R-M.

WILLIAMS, H. M, SIEVERS, C. H, & HATTWICK, M S. The measurement of musical development. *Univ Iowa Stud., Stud Child Welfare*, 1933, 7, No. 1 (New Ser, No. 243). Pp 191

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THE PEDAGOGICAL SEMINARY AND JOURNAL OF GENETIC PSYCHOLOGY

Child Behavior, Animal Behavior, and Comparative Psychology

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RACE DIFFERENCES IN SPEED OF REACTION*[1]

From the Psychological Laboratory of Vanderbilt University

MARTHA LAMBETH AND LYLE H LANIER

Direct comparisons of the psychological test performances of races differing widely in general cultural background are of doubtful scientific value The test differences usually found cannot, without further proof, be assumed to represent either the fact or the extent of hereditary disparity between the two races. This does not mean, of course, that hereditary race differences may not exist, since the lack of conclusive proof of a proposition cannot be taken as *a priori* demonstration of its contrary This type of logic pervades the writings on this subject of many sociologists, who apparently have been unduly impressed by the welfare implications of the alleged mental equality of races The social implications of facts established in race psychology cannot, of course, be escaped, but we must first have the facts. After these are securely grounded, appropriate techniques for evaluating them can be developed Neither sentimental protagonists of race equality doctrines, nor equally biased advocates of the hypothesis of the racial superiority of certain human strains, has a place in science. The question of the values involved is irrelevant to science and can be answered, if at all, only by resort to philosophic discourse There is no immediately apparent *a priori* reason why the race equality principle should have found such favor in sociological circles, unless one assumes that the doctrine of the universal brotherhood of man still motivates the earnest but often misguided efforts of workers in this field

If direct race comparisons are of dubious import, the question arises as to what type of race investigation may be undertaken with reasonable promise of unequivocal results Perhaps there is none, although there can be no doubt that certain types of work will yield results appreciably freer from ambiguity than other types For

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[1]The experimental work reported here was done by Miss Lambeth, under the direction of the senior author, the present article was written by the latter.

example, a careful study of the problem of sampling seems of fundamental importance, in the case of races in which differential effects of migration are suspected This problem was emphasized in a recent monograph by Peterson and one of the writers, and is also being studied by Klineberg. Such work involves investigation of diverse groups within the same race, without emphasis upon comparisons with other races. Another promising type of investigation is the comparative analysis of the relative amounts of difference in various performances Results of this sort are of value not only to race psychology but to the psychology of individual differences in general. If racial disparity in performance varies with different activities, an analytical method of considerable value would be available to the student of human variability. Even if no relative variation in amounts of difference for different processes could be shown, this fact in itself would be quite important

A survey of the literature reveals that comparatively little work of this sort has been attempted Most psychological race studies have been concerned merely with the application of intelligence tests (group and individual, linguistic and non-linguistic) There have been occasional attempts to subdivide these tests on the basis of different types of performances and to make comparisons for the purpose of discovering possible "qualitative" differences (8, pp. 49-52). Before the day of these mental tests, isolated and usually inadequate studies of reaction-time, memory, sensory sensitivity, and learning rate were made. Since the mental test vogue began there have been studies of fatigue, free association, learning, color preferences, and various so-called tests of "special abilities." These studies have been reviewed elsewhere (2) and will not be discussed here in detail. It is perhaps sufficient to say that their greatest value lies in the direction of methodology For example, Peterson and the writer used a variety of "musical talent," "will-temperament," and "mechanical aptitude" tests, with a view, particularly, to studying their possible value as methods The low reliability of many of them and the equivocal nature of many of the "results"—e.g., the results of "will-temperament" tests by Peterson and Lanier (8, pp. 145-147)—often render the specific figures practically valueless There has been too great a tendency in this field, as elsewhere in mental measurement, to assume that the numerical scores secured with a test mean what the test title might imply, and then to play a sort of game with the terms "heredity" and

"environment" in an attempt to *account for* the figures. A more profitable game could be played with the difficult sampling problem and with the experimental situation.

The present study is an attempt to make a comparative analysis of race differences in speed of reaction in several performances. Klineberg, in a recent monograph, has tried to show that race differences on certain of the Pintner-Paterson performance tests are entirely "speed" differences, since in "accuracy" no differences are found. Furthermore he holds that "speed" is conditioned mainly by environmental factors This is quite a far-reaching and important generalization, one which is apt to become rather easily assimilated into the dogma current in certain uncritical realms of social science. Garth, in his *Race Psychology,* has already demonstrated this by the following observations on speed differences.

> "The white man's concern for speed and punctuality may be an acquired trait, we feel. If this be so, then one racial group, being more set than another on speed of performance alone or on accuracy alone disregarding speed, might react to psychological tests with resulting differences of achievement Klineberg's results definitely point to this for Indians and Negroes as compared with whites, for he shows that his tests indicate that whites are superior to the first two groups in time, but not in accuracy of performance Furthermore he indicates that there is evidence for thinking that the differences are determined largely by environmental differences."

Garth makes no attempt to analyze Klineberg's data, which we shall show presently to be entirely inadequate to the task of establishing such generalizations. He simply accepts Klineberg's conclusions, whereas he might have inquired about the meaning of "speed" and "accuracy," and might have noted that the portentous generalizations rested mainly on the manipulation of data secured by applying *two performance tests* to rather poorly selected samplings The psychological meaning of "speed" is neither obvious nor simple, one must specify what sort of "speed" is involved, since the existence of a general "speed" trait has yet to be demonstrated That this is not merely a rhetorical objection, the results of the present study amply indicate Before considering these results, however, a brief survey of previous investigations of race differences in speed of reaction will be made.

Previous Studies of Race "Speed" Differences

Bache (1) studied the reaction-times of 12 whites, 11 Negroes, and 11 Indians in 1895, finding the Indians quickest and the whites slowest. He believed that speed of response was inversely related to general cultural level Although he found the Negroes slower than the Indians, he nevertheless "explained" the results in such a way as to accommodate them to his *a priori* view Bache's results are probably of little significance due to the few cases and to the heterogeneity of the samplings.

For the most part, race differences in rate of response have been studied by manipulating data secured with "general intelligence" or "performance" and ingenuity tests. It is often possible in such tests to divide the total time by the number of operations attempted, thus giving a crude "rate of response" index. If the time is constant, as in group tests, the number of items attempted, irrespective of accuracy, serves as a speed index The latter procedure was followed by Peterson (6 pp 61-63), who compared speed indices derived from Pressey "cross-out" tests. The general results for 489 white and 416 Negro children are shown in Table 1. These results indicate that the Negro approximates more closely to the median white performance in this "speed index" than in either absolute or relative "accuracy" "Speed" has, of course, an equivocal meaning; here it means "rate of attempting" problems, not, as might

TABLE 1

Showing the Race Differences Found by Peterson on the Pressey Tests, for Three Types of Score

The comparative values in the table are ratios of the Negro to the white medians.

Group	Number of cases	Negro median divided by white median: Number of items attempted (speed index)	Total number right	Percentage right
Urban children	W 217 N 206	85	68	78
Rural children	W 272 N 210	95	82	88

be inferred, "speed in solving" them It is possible that a low or even inverse relationship might exist between these two types of speed index. The Negro's greatest deficit is in the absolute number of "correct" reactions Intermediate between the latter and the "rate" measure we find the "percentage right." These results certainly do not conform to Klineberg's contention that it is not in accuracy but in *speed* that the Negro's deficiency is most marked (4, p. 107) These figures should, of course, be interpreted very cautiously, since the "number of problems attempted" score may be conditioned quite diversely in the two groups of children. Obviously, if the same type of conditions are not operating as the subjects in the two races proceed from one problem to the next, the "speed" index has no meaning common to the two groups and the comparison is thereby vitiated

Peterson, Lanier, and Walker (9) reported race comparisons based upon certain ingenuity and speed tests in 1925. Twelve-year-old children (69 white and 46 Negro) were given three "ingenuity" tests, while 10- and 12-year-old children were tested for speed in color- and form-naming. Unfortunately, "rate of response" was not calculated for the ingenuity test data and they have little relevance to our present problem Klineberg has, nevertheless, tried to interpret these results so as to make them support his view that race differences in psychological tests are speed differences. Performance on each of these learning tests is scored in terms of the total time, the number of trials (in two of the tests), and the number of errors The comparative measures show that the only significant differences favoring the whites are found in the case of "time" scores Klineberg construes the "total time" factor to be a measure of "speed," while "trials" and "errors" are assumed to measure "accuracy." The principal difficulty with this interpretation is the assumption that two performance variables, which he names "speed" and "accuracy," exist and are measured by the numerical test scores suggested. The "total time" required to learn a problem is a definite, objective value, but the fact that it measures some general "speed" function cannot be established in the easy verbal manner adopted by Klineberg Peterson and Lanier (8, p. 71) in a later, more thorough study with these same tests have indicated tentatively the aspects of the behavior in question which seem to be correlated with these several criteria, but such correlations are necessarily made with considerable reservation. A further ob-

TABLE 2

PETERSON, LANIER, AND WALKER'S COMPARISONS OF WHITE AND NEGRO CHILDREN IN SPEED OF NAMING COLORS AND FORMS, AND OF READING THEIR PRINTED NAMES

	10-year-olds		12-year-olds	
Test	Diff. divided by P E of diff.	Diff divided by Q_{10}	Diff divided by P E of diff	Diff divided by Q_{10}
Color naming	7.3	1 9	2 4	0 6
Reading names of colors	4.9	1 5	1 7	0 4
Form naming	4 6	1 3	0 8	0 2
Reading names of forms	3 1	1 7	2 4	0.8
Average	4 9	1 6	1 8	0 5

jection to Klineberg's interpretation lies in the fact that high intercorrelations exist among the criteria in each of these learning problems. This fact is not, of course, incompatible with variations in the amounts of difference between race medians for the different criteria, but it does indicate that many conditions operative in a given test situation affect all three scores somewhat uniformly[2]

The Woodworth-Wells color- and form-naming sheets, together with sheets of typed names of the colors and forms, were used in the same study to test rate of verbal response in 10- and 12-year-old children in the two races. Inasmuch as the color naming and naming names of color tests are used in the present study, the principal results are shown in Table 2 The first column under each age group contains the reliability indices, the second contains the differences between the medians in Q_{10} units It is apparent from inspection of the values in the second and fourth columns that the differences are much greater in the case of the younger age group, although in both the whites are faster The differences in Q_{10} units for color naming and reading printed names are, respectively, .60 and .40, as against corresponding values of 1 09 and 81 for the

[2]Incidentally, Klineberg misrepresents the authors' intent with respect to the use of the ratio Diff./P E.$_{diff}$, by saying that the authors use this value "*as representing the amount of difference* between the two groups." This ratio is, of course, an index of reliability and was never intended to represent the *amount* of difference between two medians. The ratio Diff / Q_{10} indicates the size of the difference.

present study In terms of the percentage of whites surpassing the Negro medians, determined from the probability table, these differences are 66 and 61 for the earlier study, and 76 and 70 for the present study The reasons for the smaller size of the differences for the 12-year-old subjects in the former investigation are unknown

Klineberg, in the monograph already mentioned (4), tries to show that his observed differences between white, Indian, and Negro groups on certain performance tests are mainly speed differences. Such differences are thought to be due to environment The tone of this monograph is frankly "environmentalistic," the author professing a preference (p 97) for this type of explanation He asserts (without experimental evidence as far as we can find) that "environmental factors—culture, custom, education, contact and relationship with other peoples—are much more tangible than the factor of race, psychologically speaking." Klineberg seems to be guilty of an elementary fallacy of equivocation in the use of "tangible" here It is one thing to speak of certain of these factors—but not all of them —as being tangible in the sense of being objects of perception It is quite another to assert a commensurate tangibility for the causal relationship alleged to exist with respect to their conditioning test performance Furthermore, to abandon the problem of analyzing out, albeit indirectly, the possible effects of heredity on human variability simply because the problem is difficult certainly is unjustified The attitude of special pleading which Klineberg adopts, and which, for that matter, many advocates of an exclusively *racial* interpretation of observed differences adopt, is hardly conducive to unbiased scientific analysis.

Klineberg's conclusions are based upon results secured by giving certain of the Pintner-Paterson performance tests to rural and urban groups of Indian, white, and Negro children The study involved a great deal of testing, but unfortunately the value of many of the comparisons is probably vitiated by the unreliability of the tests, by the failure to equate the groups compared with respect to age, and by an apparent failure in certain instances to allow for differences in the number of subjects who failed to complete a test. Klineberg computed "speed indices" for two of the formboards, the Mare and Foal Test and the Healy Puzzle "A" The speed index for each subject was secured by dividing the total time by the number of "moves" required to solve the problem Inasmuch as the greater portion of the monograph revolves about these speed indices, as

they vary in the several race groups, the question immediately arises as to the significance of these values. In the first place, there is the general problem of the "reliability" of the formboards, on which Klineberg gives no data. Peterson and Telford found the Healy "A" test to be quite unreliable, the correlation between two applications being only .22 (10, p. 141). This casts considerable doubt on the meaning of the results for this test. In addition, certain quite peculiar results appear in the use of this "speed index," which will be described more fully below. As an example, we may note here merely that by the Healy "A" speed index the 7-year-old Yakima Indian is "faster" than his 15-year-old fellow-tribesman. Obviously, a numerical score of this sort is, to say the least, of decidedly questionable significance. This is an illustration of a general failure on the part of the author to subject the methods employed and the results to critical analysis. We present, therefore, a summary of Klineberg's results on "speed" in Table 3 with appropriate reservations as to their meaning.

The author's principal conclusion from these figures is that, inasmuch as larger speed differences exist between urban and rural groups than between races, the observed speed differences between racial groups are therefore due to environment. He believes further that, since the speed index shows a higher correlation with *total time* than with errors (or moves), the race differences found in such tests relate to time rather than to accuracy. He should, of course, say "errors" or "moves," since the term "accuracy" connotes something not necessarily implied by the "errors" score. That a low error score implies greater "accuracy" can be deduced from these results only by equivocation with respect to the meaning of the latter term, as will be shown presently.

The fact that these speed indices are of such questionable nature as to invalidate Klineberg's conclusions would seem to be indicated by the figures in Table 4. This table shows the speed indices *by age* for the Yakima Indians, the West Virginia Negroes, and the Toppenish whites. The speed indices for the Healy "A" test represent the 7-year-old Indian as being "faster" than the 15-year-old; the 7-year-old Negro is as "fast" as the 16-year-old negro. There is better correspondence in the Mare and Foal Test, but there are striking exceptions: the 7-year-old Negro is almost as "fast" as the 12-year-old, and is "faster" than either the 10- or the 11-year-old; the 10-year-old white is almost as "fast" as the 14-

TABLE 3

KLINEBERG'S SPEED INDICES FOR HIS SEVEN INDIAN, WHITE, AND NEGRO GROUPS

Group	Index of speed Mare	N	Q	Index of speed Healy	N	Q	Av Mare and Healy
I Yakima I	3 6	75	6	4 3	71	1 5	3 95
II W Va N	3 6	73	75	2 95	72	6	3 28
III W Va W	3 4	11	1 4	2 5	11	65	2 95
IV Toppenish W	2 9	50	55	2 8	46	7	2 85
V New York N	2 9	50	55	2 6	50	55	2 75
VI Haskell I	3 1	55	8	2 3	55	45	2 7
VII New York W.	2 9	88	6	2 3	88	4	2 6
I and VI Indians	3 35	130		3 31	126		3 33
II and V Negro	3.25	123		2 78	122		3 02
III, IV, and VII White	3.07	149		2 53	145		2 8
I, II, and III Rural	3 53	159		3 25	154		3 39
V, VI, and VII Urban	2 97	193		2 4	193		2 69

TABLE 4

KLINEBERG'S SPEED INDICES FOR HIS SEVEN INDIAN, WHITE, AND NEGRO GROUPS, *by Age*, WITH SUCH DATA AS WERE AVAILABLE

Test	Age 7	8	9	10	11	12	13	14	15	16
I Mare and Foal										
Yakima I	6 7	6.5	4 5	5 0	4 4	3 2	3 8	2 9	3.0	3 6
W. Va N	4 2	5 2	4 1	4 5	4 7	4 0	3 7	3 7	3 2	3 2
Toppenish W	4.3	3 8	3 6	3.4	3 5	2 9	3 0	3 3	2 9	2.9
II Healy "A"										
Yakima I	4 5	5 5	4 5	5 0	4 3	4 3	4 5	4 5	4.8	4 0
W. Va. N	3 4	4 0	2 9	2 8	3 2	3 1	2 9	2.9	2 8	3 4
Toppenish W.	4 0	3 8	3.5	3 3	3 0	3 1	3 2	3.2	2 6	2 6

year-old. These "facts" do violence to common sense and to such correlations as are known to exist between age and level of performance in children. The conclusions based upon these results are unfortunate because they lead so easily to such general statements as those of Garth already quoted

Klineberg's evidence for the dichotomy of "speed" and "accuracy" and the assertion that no race differences exist by the latter criterion demand analysis His figures show that Yakima Indians require longer time to work the formboards, but make fewer errors (or moves) than Toppenish whites The same general result is found in comparing rural groups of each race in West Virginia, and, to a lesser degree, in New York City groups. When, however, we inspect the average scores for time and errors *by age,* we find that while time scores tend pretty regularly to decrease with age such is not true of the error scores. We find the anomalous situation of the 7-year-old Indian having the same error ("accuracy"?) score as a 16-year-old on the Mare and Foal Test, although the older child solves the problem in less than half the time needed by the younger. Except for the Healy Puzzle "A," there is little regular correspondence of error score to age, a fact which probably invalidates the generalizations in the study concerning "accuracy," just as similar figures cast doubt on the validity of the "speed indices"

Klineberg includes in his monograph speed indices computed from data secured by Woodworth with a formboard in his tests at the Louisiana Purchase Exposition in St. Louis The significance of the results depends to a great extent, of course, upon the adequacy of the samplings. Nothing is known about this important question,

although the number of cases is quite low in all except the Filipino group Klineberg tries to utilize these data to show that speed and accuracy are unrelated, or, if so, are inversely related. Woodworth examined 16 groups in all, for each of which Klineberg presents median scores for total time, moves, and speed index (rate of response on the formboard) He then eliminates the 8 lowest groups (among them being 5, each of whom has almost *identical* ranks for time and moves) and proceeds to intercorrelate the three factors for the remaining 8 groups The rank correlations between time and moves and between speed index and moves are both practically zero (.02 and —.08) A high correlation of 97 exists between time and speed of response. The reader is left to judge the merit of these correlations, based upon the 8 "selected" cases. It might be suggested that if the "moves" score on this formboard is of the nature of some of the other "accuracy" scores used in the study, a correlation of zero is to be expected, not merely with time but with everything else. This so-called "accuracy" score may be merely a chance numerical value, unconditioned in any systematic manner by the organic factors which may be assumed to operate in the determination of the *significant* criteria of test performance.

Peterson and Lanier (8, pp. 77-80) reported comparative results on speed of response in certain ingenuity tests in 1929 Twelve-year-old children of each race in Nashville and Chicago were given four "ingenuity" or learning problems, for which it was possible to compute speed indices. In addition, one of these learning tests (Rational Learning) and the free association test of the Yerkes Point Scale (number of words in 3 minutes) were given to New York white and Negro children of the same age Table 5 contains a brief summary of the results, the speed indices for the several tests being averaged. The differences in speed of response all favor the whites and they are greater in New York City than in either Nashville or Chicago The differences are, however, small and unreliable between the Chicago groups This may be due partly to the small number of whites, as well as to a possible lack of representativeness on the part of both white and Negro samplings The unusually large "speed" difference between the races in New York City is difficult to account for, although the fact that the tests there were given by several individuals may be partly responsible. It should be noted that as regards total time on the Rational Learning Test the New York whites were slightly superior, while for number of

TABLE 5

PETERSON AND LANIER'S "SPEED" COMPARISONS FOR WHITE AND NEGRO CHILDREN IN NASHVILLE, CHICAGO, AND NEW YORK CITY

Groups compared	Tests	Diff./Q_{10}	Diff /P E_{diff}	Percentage of whites above Negro median
Nashville	Four "ingenuity" tests	1.99	5 91	80
Chicago	Four "ingenuity" tests	.29	1 08	56
New York	Rational Learning	1 72	8 42*	85
	Free Association	74	4 25	75

*There is an error in Table 26 in this monograph (P 79) The Diff /P E_{diff} for Rational Learning in the case of New York children is given as 4 00, it should be 8 42

repetitions and for errors the Negroes were superior. In Nashville and in Chicago, the general performance of the whites, by all criteria, excelled that of the Negroes, the difference being greater in Nashville than in Chicago. Just how much importance should be attached to these results we are unable to say They would appear to raise problems rather than to solve them. One of the writers has pointed out in another article (5) that the "speed" difference is the only reliable one which is found in both Nashville and New York, where the samplings are sufficiently adequate to merit consideration. Whether or not this fact is proof of a "race" speed difference in the Rational Learning Test is unknown Lanier has pointed out that the argument is stronger in this case than for any other difference found by him and Peterson (5, p 217). In the same article Lanier presents certain correlations which perhaps throw light on the relationship of rate of response in the Rational Learning Test to other types of scores (total time, trials, total errors, logical errors, and perseverative errors) Intercorrelations of all these factors are presented Rate of response (speed index) is found to have no relationship to any of the other five factors, except time. Even in this case the coefficients are low, being .47 for the whites and .37 for

the Negroes This "speed" measure apparently is little related to efficiency in the test, but rather seems to reflect the subject's "readiness to respond" when the successive letters in the series are presented Time, trials, unclassified errors, and "logical" errors were found all to be closely related.

In the second part of Peterson and Lanier's study, college students in each race were given certain of the Minnesota Mechanical Abilities Tests, as well as the Downey Will-Temperament Test Both of these included "speed" tests of varying degrees of complexity. Table 6 contains a summary of the tests and results It is interesting to note that the amount of race difference, always favoring the whites, varies in general with the complexity of the performance. The Speed of Movement Test, to be described below, involves merely the unrestrained marking of vertical lines on a test sheet, and in this simple performance the two race averages are practically equal The Tapping II Test is also quite simple (8, p. 116) and the difference between the medians is small and unreliable The cancellation test appears to be more complex than either of the above, although neither the size nor the reliability of the difference reflects this, in contrast to the results of the present study. Tapping I is more complex than either of the two motor tests just mentioned and the race difference is much larger and is statistically

TABLE 6

PETERSON AND LANIER'S RESULTS OF "SPEED" TESTS APPLIED TO WHITE AND NEGRO COLLEGE STUDENTS

	Number of cases W	Number of cases N	Diff /Q_{10}	$\frac{\text{Diff}}{\text{PE}_{diff}}$	Percentage of whites above Negro median
A Minnesota Tests					
*1 Tapping I	190	94	1 11	5 90	68
2. Tapping II	195	95	35	2 57	66
*3 Speed of Movement	190	95	09	46	53
*4 Cancellation	193	95	46	2 98	63
5 Substitution	156	159	2 24	14 42	92
6 Form Board	195	180	2 15	4 10	91
B Downey Speed of Movement Test	94	93	11	41	61

*These tests were used in the present study also.

reliable, in agreement with our own results, shown below in Table 10. The substitution and formboard tests yield enormous and reliable differences favoring the whites[8] The size of these differences is approximately that found for the group intelligence tests used by Peterson and Lanier The general conclusion which seems justified from these results is that the degree of white superiority varies somewhat directly with the complexity of the performance. In simple speed of reaction the two races are of equal ability, as the reactions become more complicated, the white superiority increases It is obvious that Klineberg's hypothesis is meaningless as applied to these data. If one prefers to characterize the Negro deficit as a "speed" difference, this statement should certainly be qualified by the statement that it is in the more complex performance that the "speed" difference occurs And this, of course, raises the question as to whether or not the term "speed" has any meaning, in the sense in which Klineberg uses it.

The Present Investigation

The studies of race "speed" differences which have been reviewed in the preceding pages seem to raise problems rather than to solve them. The present investigation is an attempt to secure additional data on possible speed differences in processes differing in complexity. These data will, of course, have to be checked carefully with those secured in other localities before their real significance can be determined But the results should serve to define the problem more definitely and possibly to indicate trends in race study which may be more fruitful than giving group intelligence tests, a popular and relatively profitless procedure The general plan of the work involved the application of the Stanford-Binet scale—a "general intelligence" test not involving time to any appreciable degree—the Rational Learning Test, already mentioned, and six "speed" tests The latter differ considerably in the nature and complexity of the reactions required. These various tests should enable one to check Klineberg's hypothesis that it is not in *accuracy* but in *time* that the race difference appears. Time is involved hardly at all in the Binet tests, while in the "speed" tests it is of paramount importance The Ra-

[8]The same subjects were given all of the first six tests listed in Table 6, but due to the failure on the part of many of the Negro subjects to follow directions for the speed tests, many of their records had to be discarded

tional Learning Test lies somewhere between these two types of tests as regards the importance of time

1 *The Subjects* The subjects used were 30 12-year-old white and 30 12-year-old Negro boys in certain public schools of Nashville, Tennessee [4] In order to secure representative samplings at this age, the percentage of subjects used in a given grade was approximately the same as that for the city as a whole, as determined from the total city enrollment for the spring of 1930 The grade distributions of the subjects are shown in Table 7. Incidentally, the median grades for both races are almost the same as those of Peterson and Lanier, for 12-year-old subjects, secured six years earlier. The Negro retardation is slightly less here, the median grade in 1924-25 being 5 2, while that in 1930-31 is 5.6. The median grade for the city as a whole is, however, slightly lower than that of our Negro subjects The city median and our median are almost identical in the case of the whites

2 *The Tests and Their Administration* The tests used included the Stanford Revision of the Binet-Simon Tests, the Rational Learning Test, one of the Minnesota Paper Tapping Tests, speed in reading printed names of colors, Minnesota Speed of Serial Movement Test, the Woodworth-Wells Color Naming Test, and cancellation of A's All of these tests were administered individually Two sittings were required, the first one being devoted to the Binet tests, the second to the Rational Learning and speed tests The average time required for both sittings was approximately an hour and a half

The Stanford Revision of the Binet-Simon tests needs no detailed description The directions prescribed by Terman, the author of the test, were followed closely There are many disadvantages in using a scale of this sort for comparative purposes. The principal difficulty is the fact that the same problems are not presented to all subjects, with the result that one must rely completely upon the accuracy of the author's standardization in assigning to the reactions the numerical values designed to indicate level of performance

[4]The authors are indebted to Mr H F Srygley, Superintendent of the City Public Schools of Nashville, to Mr J J Keys, Director of Community Relations, and to the principals of the schools for their kind cooperation The white subjects were secured in Warner School, the Negroes from Meigs and Cameron schools The socio-economic status of children in these schools is about average for the respective races, although the whites may be somewhat below average

TABLE 7

Grade Distributions of the 12-Year-Old Boys Used in the Study and of All Children of This Age in the Entire City

		Grades								
		2 or below	3	4	5	6	7	8	9 or above	Total	Median Grade
Number	W		2	2	5	8	8	4	1	30	6 75
	N	4	4	5	5	5	4	2	1	30	5 60
Percentage	W		6 7	6 7	16 7	26 7	26 7	13 3	3 3	100 0	
	N	13 3	13 3	16 7	16 7	16 7	13 3	6 7	3 3	100 0	
Percentage for city	W	4	6.12	7 4	16 1	27 9	26 6	12 5	2 9	100 0	6 71
	N	13 9	14 30	16 4	18 7	15.2	13 7	5.7	1 9	99.8	5.28

A "point scale" is undoubtedly a better type of test for this work, and the Yerkes Point Scale would have been used but for the fact that Lanier found it unsatisfactory for the 12-year-old children which he examined in New York (8, p. 52). The Stanford Revision was selected in view of the fact that it contained problems sufficiently difficult to differentiate the subjects at the higher levels Furthermore, this type of test was being used merely in an auxiliary capacity.

The Rational Learning Test, devised by Joseph Peterson, has been used in several race studies and has been described adequately (8, pp. 26-29) The subject is required to find, at first by guessing, the numbers (1 to 7) which have been assigned at random to the seven letters, A, B, C, D, E, F, G, and to associate a number with its appropriate letter sufficiently well to be able to give the series twice correctly. An easy fore-exercise consisting of three letters and numbers preceded the regular test Record is kept of each response made, right or wrong, and the subject's performance can be rated as to total time, the number of trials, and the number of errors (no study of the *types* of errors was attempted here). The average time per reaction was computed by dividing the total time by the number of reactions. Such an index is necessarily inaccurate as a measure of "speed," since it reflects many factors other than speed For one thing, the total time includes the experimenter's calling out of the successive letters.

The Minnesota tapping test blank contained six blocks of small 5-millimeter squares, each block being 30 squares long by 7 squares high The subject was instructed to put a dot in each square as rapidly as possible Fifteen seconds were allowed for tapping in each block of squares, with 30 seconds' rest between trials. The score for a block was computed by counting every square which contained a dot. The first block was omitted in determining the rate of response score The latter was secured by dividing the 15-second period by the number of dots in the "median" block of squares.

The test sheet for the naming of printed names of colors contained fifty names of the colors green, red, yellow, blue, and black, in random order and triple-spaced They were secured by typing the names of the last 50 colors on the Woodworth-Wells sheet in reverse order The subject was handed the sheet and instructed to read the names of the colors as rapidly as possible. Three trials were made, with 30 seconds' rest between trials. The experimenter

recorded the time required for each trial The median time of the three trials was divided by 50 to secure the time per reaction.

In the Minnesota Speed of Movement Test, the subject was required to make nearly vertical lines (no restrictions as to type of line except that each one must represent a separate movement) as rapidly as possible between the two horizontal lines of a slender rectangular bar which extended across the test sheet. There were three groups of four such figures in each The subjects marked for 15 seconds in a group, with 30 seconds' rest between groups. The total number of marks constituted the score for each trial The speed index was secured, as in the other tests, by dividing the time per trial by the number of marks made on the median trial.

The Woodworth-Wells color naming sheet contains 100 colored squares (G, Bk, R, Y, and B) in random order. This sheet was cut in half and the first 50 squares used in the present experiment The subject was instructed to call out the names of the colors as rapidly as possible, and, if he miscalled or skipped one, to go to the next one without stopping Three trials of 15 seconds each were given, with a 30-second rest period between each trial

The cancellation test blank was prepared at the University of Minnesota and, like those already mentioned, constituted one of the series of "mechanical aptitude" tests developed there. The sheet contained printed capital letters, distributed in random order The subject was instructed to mark out all of the A's as rapidly as possible. The experimenter kept time with a stop-watch The time per reaction was found by dividing the total time by the number of A's crossed out. Omission of A's and crossing out other letters were disregarded, since both tended to lower the speed index automatically

The sixth speed test used was the Free Association Test of the Binet-Simon scale This is included in the 10-year group of that test and was given to all subjects. The subject was instructed to call out all the words he could in 3 minutes The time divided by the number of words named gives the rate of response

3 *Experimental Results.* The significance of the various race comparisons will be clearer if an analysis is first made of the interrelations existing among the scores on the several tests It is unlikely that we shall be able to answer definitely the question often put to workers in the field of mental measurement, namely, "What do your tests measure?" Nevertheless, a comparative study of the inter-

relations existing among tests requiring apparently diverse types of behavior should throw some light on the question as to whether or not the various performances are really diversely conditioned It may be found that different test names are not paralleled by the evocation of basically differently behavior mechanisms, or that these relations differ for the two races, a most important possibility. Such an analysis is important not only for the student of race psychology, but for the general theory of "mental organization"—the problem of the "nature of ability," about which much controversy in mental measurement has centered Following the analysis of the correlation coefficients, comparisons of race averages on the various tests will be presented The third section will deal with a comparison of speed scores for race groups equated with respect to Stanford-Binet IQ, and the problem of the relative variability of the races on the several tests will be considered in a fourth section.

a An analysis of intercorrelations of the several tests We have seen in our historical survey that too often test *names* are presumed to represent corresponding types of processes and that a nominal difference has frequently been taken for a functional one. The correlation method may not provide a final criterion of interrelationship (for spurious factors cannot always be eliminated and purely chance correlations may delude the unwary manipulator of statistical values), but it serves at least as a check on the diversity alleged to obtain among superficially different types of test performances Furthermore, if the correlations represent real relationships among the several types of performances, the nature of these interrelations is important in relation to a comparative analysis of the "mental organizations" of the respective races The possibility that two races might differ with respect to homogeneity of behavior traits (the relative presence or absence, for example, of some general "factor" such as Spearman has emphasized) is one which has scarcely been mentioned in race studies. Peterson and Lanier (8) presented several tables of correlation coefficients in their monograph and noted in two places that the intercorrelations of test factors were higher on the average for the Negroes than for the whites (pp 81-82 and 145) They state that such higher intercorrelations might be due to greater heterogeneity in the Negro sampling, or to a difference in mental organization The following statement summarizes their argument on this point

> "If the intercorrelations were all 1.00 it could be said that there is so little diversification in mental functions as to make all tests equally good . On this view, the higher the correlations, other things being equal, the simpler would be the mental organization of the subjects tested, and since our results show higher coefficients for the negro than for the white, the negroes would be considered as having less diversification in mentality than the whites This lesser diversification might, however, be due to less specialization in the environment of the negro rather than to an innate difference" (8, pp 81, 84)

The intercorrelations of the test factors employed in the present study are shown in Table 8 The next to last column in the table contains the average of the coefficients secured by correlating the variable listed at the left with all other factors. In the case of the Rational Learning Test factors, the correlations of each of these with the others were omitted in computing their averages The last column contains rankings of these averages from highest to lowest for both races. For example, the average intercorrelation of Binet mental age with the other 10 factors is the highest obtained, for both whites and Negroes, thus securing for it a rank of "1."

The high degree of correspondence of these rankings in the two races is interesting The correlation of these rankings, by the rank-difference method, is .78. These results might indicate a similarity of the two races in the type of relationship existing among the functions presumably involved. This evidence would seem to argue against any basic "qualitative" difference in "mental organization" in these races. The original correlations are, however, so low in many instances, especially in the case of the whites, that one cannot attach much importance to these results

When the *size* of the coefficients of correlations is considered, it is apparent at once that those of the Negroes are higher. This is in agreement with the results of Peterson and Lanier, mentioned above The average intercorrelation—an average of 52 coefficients for each race—of the whites is .16, while that of the Negroes is 34, the difference of .18 has a probable error of .029 This result might be interpreted to mean either greater homogeneity of the organization of behavior traits in the Negro, or relatively greater heterogeneity in the Negro sampling with respect to the performances measured here. It must be remembered, however, that one could scarcely secure a more homogeneous group than one of this sort, in which age, sex,

TABLE 8

INTERCORRELATIONS OF THE ELEVEN FACTORS FOR THE TWO RACES

The upper coefficient is that of the white, the lower that of the Negro Probable errors are given in the lower part of the table Factors are numbered across the top as they are given down the side of the table

	Test	1	2	3	4	5	6	7	8	9	10	11	Average Amount	Rank
1	Binet mental age		.51	42	46	15	05	27	27	.27	70	30	340	1
			44	49	37	18	.72	58	60	50	74	60	522	1
2	Rational Learning	091		94	.87	11	—05	08	—09	10	64	00	162	4
	time	099		89	87	50	17	.27	.18	21	23	28	285	8
3	Rational Learning	.101	014		91	—.27	—13	03	—13	.13	52	—07	063	9
	errors	093	025		87	10	26	16	17	16	27	36	246	9
4	Rational Learning	097	029	021		—30	—20	03	05	—04	45	—08	046	10
	trials	106	029	029		14	23	02	15	17	16	14	172	10
5	Rational Learning	120	121	.114	.112		08	.15	—06	24	.06	19	.035	11
	time per reaction	.119	092	122	120		—18	19	10	.23	03	09	138	11
6	Minnesota Tapping	122	122	121	118	122		27	.41	05	12	27	087	8
		059	.119	.114	116	119		56	74	52	72	49	423	3
7	Names of colors	114	122	123	123	.120	144		31	41	22	34	.211	3
		084	118	124	127	.122	087		.47	.64	60	45	394	5
8	Minnesota Speed of	114	122	.121	.122	122	102	111		—03	05	18	096	7
	Movement	078	119	119	.120	122	055	099		46	46	59	392	6
9	Color naming	114	122	121	123	115	122	.102	.123		42	—09	146	5
	(printed colors)	092	.117	120	119	116	089	075	097		73	.45	407	4
10	Cancellation	.062	072	089	098	122	121	117	122	103		06	324	2
		055	116	114	120	123	059	081	097	.057		59	453	2
11	Free Association	.112	123	122	.122	118	114	.115	119	122	122		110	6
	(no words in 3 min)	078	113	106	120	122	093	101	078	098	078		350	7

TABLE 9

COMPARISONS OF AVERAGE INTERCORRELATIONS OF MENTAL TEST SCORES OF WHITES AND NEGROES, BASED UPON RESULTS OF LANIER, PETERSON AND LANIER (8), AND THE PRESENT STUDY

Investigator and type of tests intercorrelated	Number of subjects involved in the several correlations W	N	Number of correlations	Average intercorrelation W	N	Difference	P E. of diff	Diff. divided by $P.E._{diff}$
Lanier: three ingenuity tests, 12-year-old children	69	46	21	—.035	225	260	030	8 68
Peterson and Lanier ingenuity and general intelligence tests of 12-year-old children	60-119	69-92	136	155	228	073	.020	3 65
Peterson and Lanier. group intelligence tests of adults	15-169	14-159	36	275	305	030	028	1 07
Peterson and Lanier Otis S-A and Seashore music talent tests	198-380	167-289	21	213	318	.105	019	5 52
Peterson and Lanier Mechanical Aptitude tests	58-184	22-93	28	159	153	—006	029	—21
Present study general intelligence, ingenuity, and speed tests	30	30	52	160	340	.180	029	6.20
Average				154	261	107		4 15

and school grade are controlled. If a Negro group selected in this fashion shows greater heterogeneity than a similarly selected white group, this problem in itself becomes one of great importance for race study and for the psychology of individual differences in general. The heterogeneity or variability within a group for a given test can be measured to some extent by the "coefficient of variation" (standard deviation divided by the arithmetic mean). Peterson and Lanier found that their 12-year-old Negro subjects were somewhat more variable on the average than the whites, but the differences were slight. Results of variability measurements for the present groups are given below in Table 11. In general, they show that there is little difference between the two groups in variability.

One would hardly be justified, in the absence of more conclusive evidence, in assuming that the slightly greater variability of the Negroes produced the higher *intercorrelation* among their scores on a variety of mental tests, unless one begged the question by assuming in a sense the existence of the very type of homogeneity of functional organization (irrespective of its cause) which is in question. This question is quite fundamental for the "psychology of ability," as well as for race psychology. We might therefore present here a summary of similar results from previous studies for comparison with our own figures. This summary is made in Table 9, which includes results from six sets of correlations. The first row in the table contains figures based upon intercorrelations of the three ingenuity tests given by Lanier[6] to 12-year-old white and Negro children. The figures in the next row are also based upon intercorrelations of scores of 12-year-old children, the 17 test factors intercorrelated included group general intelligence tests and the same three ingenuity tests used by Lanier in the preceding study. The figures in the next three rows are based upon intercorrelations of scores made upon several types of tests by the white and Negro adults studied by Peterson and Lanier (8). The last row in the table contains the results of the present study, already presented above.

The figures in Table 9 show decidedly higher intercorrelations for the Negro in the case of 12-year-old children (rows 1, 2, and 6). The results for the adults reveal practically no difference in two of the comparisons (group intelligence test scores and mechanical

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[6]These correlations have not been published although the race differences, as regards average performance, were presented in the article by Peterson, Lanier, and Walker (9).

aptitude tests) The other set of averages, based upon intercorrelating the Otis Self-Administering Test and the six Seashore Musical Talent Tests, shows a considerably higher average intercorrelation for the Negroes The data upon which the correlations for adults were based are probably of a much less reliable character than were the tests on the children Furthermore, little or nothing is known about the nature of the adult sampling, either as regards relative heterogeneity or representativeness. The children were both better selected and more carefully examined, and the data for them are accordingly more trustworthy.

The fact that the average *amount* of intercorrelation is much higher in the case of the Negro seems to argue for the relatively greater operation of a "general factor" among the conditions which determine Negro performance. Undoubtedly, the low numerical magnitude of many of individual correlation coefficients and their statistical unreliability, in many instances, make it impossible to draw any final conclusions But the results are sufficiently definite and persistent in the several sets of correlations (especially in the case of well-selected subjects and carefully administered individual tests) to define this as an important problem for further research This higher intercorrelation might conceivably be due to any one of several causal factors, or to a complex of factors. We have already mentioned, and dismissed as far as these data go, the possibility that greater heterogeneity in the Negro sampling might operate to produce these higher correlations It has been suggested that the presumably more differentiated environment of the white might produce a greater specialization of "abilities" which would result in a lower average intercorrelation among test scores for that race Or the Negro might be basically of a simpler, more homogeneous, more "primitive" type of organization We cannot conclude from our data which hypothesis, if either, is correct, and speculation is useless. The problem must be left, as indicated above, to future research

It was noted above that, on the average, the several tests show a higher correlation with Binet mental age than with any other factor, for both races For the Negroes, all of the correlations with Binet mental age are fairly high and are statistically reliable, except that with rate of response in Rational Learning. In the case of the whites, the correlations with mental age are lower and are unreliable, except for that with cancellation and with the three Rational Learning Test criteria (exclusive of the "speed index") If one

were to generalize as to the relations of the speed tests to Binet mental age, it could be said that there is little correlation in the case of the whites, while in the case of the Negroes the relationship is quite marked This is but a corollary of the general interrelationships existing among the test scores The "speed index" computed for the Rational Learning Test shows little correlation with any of the other factors The intercorrelations among the three Rational Learning scores—time, errors, and trials—are very high, a result agreeing with previous work

If the Rational Learning speed index be excluded, it will be observed that the correlations among the speed tests are generally low and unreliable for the whites, while for the Negroes they are much higher and are, in every instance, reliable statistically. The average intercorrelation for the latter group is 65, while for the whites the average is only 23. This is a most important point to be considered in relation to the race comparisons which follow, since it indicates that in the case of the Negroes there are many apparently diverse speed processes conditioned to a much higher degree by a common set of factors than is true of the whites It is not improbable that the common factors are in large measure those which condition the Binet mental age scores, since the speed tests show a rather high average correlation with mental age of .62, almost the same value as was found for the average intercorrelation existing among the speed tests. In other words, "speed of reaction" as measured here is much more closely related to "general intelligence" test score in the case of the Negroes than for the whites.

b Comparisons of race averages. The race differences on all test criteria are shown in Table 10 The median is used as the measure of average performance, in preference to the arithmetic mean, since extremely low or high scores in a small sampling affect the mean unduly The quartile deviation is used as the index of variability[9] The medians for all test factors are given in the first column of Table 10, the quartile deviations (Q) are shown in the second column. The third column of the table shows the difference between the medians in raw score units, followed in column 4 by the probable errors of these differences The latter measure is the statis-

[9]Both the means and the standard deviations are used below, however, to determine the relative variabilities on the several tests These values are available in Table 11 in case a comparison of the differences given by the two types of average is desired

TABLE 10

MEDIANS, QUARTILE DEVIATIONS (Q), AND THE VARIOUS COMPARATIVE MEASURES EMPLOYED FOR ALL TESTS USED IN THE STUDY

The units of measurement for factors 6-12 inclusive are seconds, representing average rate of response ("speed index"). In every test, except the Binet, the lower the score the greater the efficiency.

	Test		Median	Q	Diff. in mds	P.E. of diff	Diff. divided by P.E. $_{diff}$	Diff. divided by Q_w	Percentage of overlapping of medians W above N	N above W
1	Stanford-Binet mental age	W	140 mo	12 96	22 5	4.28	5.25	1 74	90	7
		N	117 5	13 45						
2.	Stanford-Binet IQ	W	96 43	8.75	18 93	2 93	6 46	2 16	93	4
		N	77.50	9.37						
3	Rational Learning time	W	11 80	5 86	3 20	2 20	1 45	55	64	34
		N	15 00	7 62						
4	Rational Learning errors	W	123 40	45 00	3 26	18 00	18	07	53	48
		N	126 66	65 00						
5	Rational Learning trials	W	16 00	4 97	.67	1 85	36	13	53	47
		N	16 67	6.37						
6	Rational Learning rate of response	W	3 15"	475	700"	160	4 36	1 47	83	20
		N	3 85"	512						
7.	Minnesota Tapping	W	420"	037	060"	017	3 52	1 62	79	30
		N	480"	065						
8	Naming names of colors	W	504"	057	046"	045	102	81	80	43
		N	.550"	208						
9	Minnesota Speed of Movement	W	234"	020	001"	.009	111	05	50	50
		N	235"	035						
10	Woodworth-Wells Color Naming	W	800"	069	075"	028	2 68	1 09	78	36
		N	875"	104						
11	Cancellation of A's	W	1 40"	215	230"	077	2 99	1 07	70	30
		N	1 63"	.260						
12	Free Association		2 72"	500	590"	.178	3.31	1 18	83	14
		N	3 31"	600						

tical index of the reliability of a difference between averages Other things being equal a difference which is as much as four times its probable error is considered "reliable" (i e, indicative of a very high degree of probability that subsequent comparisons of the same sort would yield differences greater than zero) This ratio of the difference to its probable error has been termed the "critical ratio"; column 5 in Table 10 contains these ratios for the present comparisons.

The last three columns contain values which express the amount of difference for each factor in *relative* units. The first of these, shown in column 6, is a quotient obtained by dividing the difference by the quartile deviation of the group usually making the higher score (in this case the whites) This measure reduces the absolute difference on each of the several tests, expressed in varying scale units, to a standard unit, thus making them all directly comparable. The advantages of this standard unit over other methods of reducing raw scores to comparable units have been emphasized by Peterson (6), who introduced the measure into race testing. The percentages of each group passing the median of the other group, as determined by actual count from the distribution tables, are given in the last two columns of Table 10 It is obvious that the amount of overlapping computed by this method *should* agree with that indicated by the ratio Diff $/Q_w$, since the interpretation of the latter is based upon the percentage of cases in the normal frequency curve included in the area between the two medians. A comparison of columns 6 and 7 shows, however, that this agreement is not perfect This fact indicates, of course, that the distributions are not "normal," and hence that the use of these various statistical indices of both the amount and the reliability of differences is somewhat questionable It will be recalled, however, that our purpose is not so much to measure the absolute amount of the race differences as to compare the relative amounts of difference on the various types of performance These statistical values are, accordingly, used mainly as devices to facilitate such comparisons, not as measures of the absolute magnitude of the differences. With these qualifications concerning the significance of the measures, the detailed comparisons will now be made.

1) *The Stanford-Binet scale* A large and probably significant difference is found between the race medians for this scale This is true both for the "mental age" scores and for the "intelligence

quotients." In terms of the ratio Diff./Q_w, the respective differences are 1 74 and 2 16, by actual count 90 and 93% of the whites equal or surpass the Negro medians, respectively This is an enormous difference, especially when one considers the fact that the whites are somewhat below "normal," if an average "intelligence quotient" of 1.00 be considered "normal" for a given age group. Incidentally, these results are very similar to those secured six years earlier by Peterson and Lanier with a group point scale based upon the Binet tests (8, pp 45-46) In that study the Diff./Q_w was 3 05, with 94% of the whites surpassing the Negro median by actual count. This group scale involved time limits for the various performances and, although the time was entirely sufficient as a rule to permit completion of the problems, nevertheless it might be objected that the timed performances would operate to the disadvantage of the Negro This argument is scarcely relevant in the case of the individually administered Stanford-Binet scale used in the present study, since the time element is practically absent

Another type of objection to the Binet tests is the fact that they involve the understanding and use of verbal language to a considerable extent, thus handicapping the Negro whose opportunities for language development are more limited. Undoubtedly, this is a real obstacle to an unambiguous interpretation of the results, although just the extent to which the observed difference is due to *accidental* language inequalities or to real deficiency in linguistic capacity cannot be ascertained. It should be noted that Peterson and Lanier found very large differences between Nashville 12-year-old children in each race on the basis of *non-linguistic* "general intelligence" tests On the Myers Mental Measure 96% of the whites surpassed the Negro median, while on five of the International Group Mental Tests, an average of 70% of the whites surpassed the Negro average. In New York, however, the differences both by the Yerkes Point Scale (an individual test) and by the Myers Mental Measure were much less (59 and 54% of the whites, respectively, surpassing the Negro medians) These apparently conflicting results naturally raise the question of the relative importance of environmental influences and selection in producing the better showing of the New York Negroes This question cannot be answered from data now available.

It is probably safe to conclude that the differences found on the Binet tests are not due to differences in "speed," as Klineberg tried

to show for his performance tests And in view of the fact that this urban Negro sampling is probably above the average of this race in America, it is probable that a rather high degree of its deficit in performance on these tests can be attributed to heredity This conclusion must, of course, be merely tentative in view of the many factors other than heredity which might condition such performances as those studied here, and which have received little experimental study

2) *The Rational Learning Test* Four criteria of performance on this test are used in these comparisons time, errors, trials, and rate of response The races are approximately equal in average trials and errors, as the data in Table 10 show. The whites are somewhat superior in the total time required to complete the test, the difference being 55 Q_{10} units, 64% of them surpass the Negro median. In rate of response ("speed index") the whites excel the Negroes markedly and "reliably", the difference in Q_{10} units is 1.47, and 83% of the whites surpass the Negro average. These results are in substantial agreement with the Nashville results of Peterson and Lanier (8), who found the difference in Q_{10} units to be 1 25, 44, —10, and 1 29 for time, errors, trials, and rate of response, respectively In terms of overlapping, they found the respective percentages of whites above the Negro medians to be 76, 60, 47, and 77 The differences for total time and for errors were both somewhat less in the present study

These differences are less than those found in the case of the Binet tests. If one were to accept these criteria for what their names imply, one might conclude, somewhat as Klineberg did, that in "accuracy" (errors) the Negroes practically equal the whites, although in total time a small white superiority is found (the difference is not reliable statistically however) It is in rate of response that the only reliable difference occurs, the white superiority by this criterion is quite marked, as was noted above Interpretation of these results is difficult, since performance on a learning test of this sort probably depends upon many conditions Peterson and Lanier have suggested that the "trials" factor reflects ability in retention, rather than in rational organization (8, p 69) This seems to be especially true after the first or second trial Our results would then seem to mean that the whites respond more rapidly and hence finish the problem more quickly, but that they require as many repetitions and make as many errors as do the Negroes Lanier's (5)

analysis of the types of errors made revealed that the Nashville whites make fewer "logical" and fewer "perseverative" errors, although only for the latter type was the difference reliable. An analysis of the types of errors has not been attempted for the present data.

One should, of course, be cautious in attributing to each of the several criteria of a test like this a differential relationship to behavior traits. Considerable analytical experimentation would be necessary before any such correspondences could be established The superficiality of some of Klineberg's analyses of "speed" and "accuracy" illustrates the danger of such "correlations" Furthermore, we have already noted the high degree of correlation obtaining among all of the Rational Learning Test factors, if we exclude rate of response This might be interpreted to mean that time, error, and trial scores measure practically the same processes, i e, that they are similarly conditioned. Such correlations within homogeneous race groups are not necessarily incompatible, however, with variation in the sizes of differences between race averages. Our results show, for example, that although the correlation between time and errors in Rational Learning is very high for both races, nevertheless, the differences between medians is greater for time than for errors. Even greater discrepancies of this sort were found by Peterson and Lanier (8). Klineberg has used this argument in trying to maintain that speed and accuracy are inversely related in the case of two races where differential sets for speed and accuracy may exist, although within the same race the correlation between speed and accuracy be high. The possibility of such a relationship would not, however, insure its occurrence in a specific case, and we cannot designate definitely for the Rational Learning Test the aspects of the learning process represented by the time, error, and trial scores, respectively

The "speed index" was found to have little correlation with any of the other factors except total time in the case of the Negroes (r equals 50) This criterion, furthermore, shows a large and reliable race difference in favor of the whites, thus agreeing with the results of Peterson and Lanier for both their Nashville and their New York comparisons In New York, the Negroes excelled the whites markedly on the basis of the trials and the errors criteria, yet their *rate of response* was slower. There seems to be no other conclusion than that the whites are more "responsive" in this test situa-

tion than the Negroes, they react more quickly, although they make practically as many errors and require almost as many trials The significance which this "speed index" may have for an analysis of the general problem of race speed differences will be indicated below. The speed difference found in the Rational Learning Test impresses the writers as being of the nature of a temperamental difference, a difference in social "sensitivity," rather than in facility in handling the "rational" aspects of the problem The total time would tend perhaps to reflect the latter factor The whites seemed to the examiner to be more alert, over-anxious, whereas the Negroes were lethargic. The slower time does not seem to imply "proceeding with calm and deliberation," which Klineberg suggests as a correlate of slowness (4, p 101).

3) *Results of the speed tests.* The comparisons of the race groups on the basis of performances stressing speed directly are shown in rows 7-12 of Table 10 The raw score in each case is expressed in terms of 1/1000 sec. In general, the differences are statistically unreliable, inasmuch as the ratio Diff./P E_{diff}, given in column 5, is in every case less than 4 It would seem, considering the magnitude of the differences, that for all factors except 8 and 9 the unreliability might be attributed to the small number of cases. The low reliability index does not necessarily imply that no real difference between the groups exists, since the probable error of the difference is a function both of the variability of the scores and of the number of cases The amount of difference would have to be great, even with "normal" variability, to produce a "statistically reliable difference" between the averages of two groups consisting of only 30 cases each Furthermore, such an index of "statistical reliability" might be quite misleading, due to possible chance variations in the scores of such a small group As Peterson and Lanier remarked "The statistical formula for reliability determinations makes no allowance for unfairness of samplings and, under the conditions which we confront, can have only little value and must be used with extreme caution" (8, p 5).

The two types of comparative measures used do not agree as to the relative sizes of the differences for the several tests. The ratio Diff $/Q_{10}$, given in column 6, shows the greatest difference for the Minnesota Tapping Test, with Free Association, color naming, cancellation, reading printed names of colors, and the Minnesota Speed of Movement Test following in descending order of magnitude of

difference All differences favor the whites, although in the case of Minnesota Speed of Movement the two race medians are practically identical. The rank order of the differences on the basis of the percentage of whites surpassing the Negro median, by actual count, is: Free Association (83), naming names of colors (80), Minnesota Tapping (79), color naming (78), cancellation (70), Minnesota Speed of Movement (50, no difference). The most striking discrepancy between the two comparative measures occurs in the case of the reading of the printed names of colors In terms of the Q_w unit the difference between the medians on this test is next to the smallest of the six, while by the percentage of overlapping measure the difference is next to the largest This discrepancy is due to abnormality in the white distribution, where 12 of the 30 cases lie within the same class interval. Inasmuch as 43% of the Negroes surpass the white median, while 80% of the whites surpass the Negro median, due to such unusual concentration of white scores, this measure is evidently the poorer of the two. The difference of 81 Q_w units, which implies that 71% of the whites surpass the Negro median, is probably a better index of the relative amount of difference between the two groups on this test

A study of the relative amounts of difference in Q_w units reveals that in simple, unrestrained serial movement (Minnesota Speed of Movement Test) the races are about equal in speed (Diff /Q_w equals 05) On the other hand, in the Minnesota Tapping Test, which involves the placing of *one dot and only one* in each of a series of small squares, a large and almost "reliable" race difference of 1.62 Q_w units is obtained This test stresses both "speed" and "accuracy," the latter in the sense of requiring that the movement be directed to a definite area on the test sheet These results illustrate the fallacy committed by Klineberg in his generalizations about the whites excelling Negroes and Indians in "speed," with no difference as to accuracy In the present instance, when simple "speed," uncomplicated by any necessity for "accuracy" ("selectivity" of movement), is measured, we find no race difference, while a large margin of white superiority is found for a more complex test, presumably one involving "accuracy" Peterson and Lanier obtained almost identical results for these two tests on applying them to college students in the two races The differences in Q_w units for the speed of movement and tapping tests were 09 and 1 11 (8, p. 138) Converting these values into the percentage

of whites above the Negro median, from the probability table, we get 52 and 77, as against 51 and 86% for the present study. By actual count the corresponding percentages of whites above Negro medians are 53 and 68 for Peterson and Lanier's data, and 50 and 79 for the present study If one were to generalize at all, Klineberg's deductions would be *reversed* The point is, of course, that one cannot generalize concerning "speed" or "accuracy" The attempt should instead be made to define carefully the conditions under which the "speed" or "accuracy" scores are elicited "Speed" is probably no unitary factor operating alike in all performances, and the same is true, no doubt, of "accuracy."[7]

The important result which emerges from a study of the differences obtained for these speed tests is that the more complex the performance the greater the race difference If one include the "speed index" of the Rational Learning Test in this general comparison and rank the performances on the basis of amount of difference between medians, in Q_{10} units, the following order is secured. Minnesota Tapping (1 62), Rational Learning rate of response (1 47), Free Association (1 18), color naming (1 09), cancellation (1.07), naming names of colors (81), Minnesota Speed of Movement (05). There would perhaps be disagreement among psychologists as to whether or not this order could be called one of decreasing "complexity" It could perhaps be generally agreed that the two tests showing the least amount of difference are the "simplest." The other five tests undoubtedly demand more complicated reactions and might at least be called "complex" as a group, in contrast to the other two tests The generalization indicated above, namely, that in simpler speed processes no significant differences are found, whereas in speed of more complex reactions large differences favoring the whites are secured, would then seem to be justified, as far as these data go This same trend was found in the results of Peterson and Lanier (*supra*, Table 6) Incidentally, for the three tests used by them and used also in the present study, the same order of magnitude of difference was found. According to their figures the

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[7]The senior author has in preparation an article entitled "The Interrelations of Speed of Reaction Measurements," in which data are presented in substantiation of this point of view Little or no correlation is obtained among speed measurements where the performances correlated involve diversity in postural and effector mechanisms, while high correlations are found when these are identical or similar

three tests rank in descending order as follows (based upon Q_w units): tapping (1.11), cancellation (.46), speed of movement (.09). The fact that such similar results were secured from both children and adults, under diverse experimental conditions (individual and group "tests," respectively), seems to support rather strongly the general interpretation advanced here.

c Speed differences in relation to level of ability This fact that the Negro deficit in performance increases roughly with complexity of performance is undoubtedly of great importance Much more extensive research as regards both the number of cases and the variety of performances must, of course, be carried out before the full import of the present results can be determined. Nevertheless, the internal consistency of the results and their agreement with preceding similar studies justify considerable reliance upon the validity of the generalization made above. They indicate, on the negative side, that there is no justification at all of the practice of *dismissing* differences revealed on general intelligence and performance tests on the grounds that they measure "speed" or reflect inequalities in educational opportunities.

In view of the fact that the Negro deficiency increased with the complexity of the performances, being greatest on the Stanford-Binet test, it seemed worth while to compare two groups equated for the Stanford-Binet score. Accordingly, two groups were made up by "pairing off" individuals in each race who had approximately the same intelligence test score (IQ). Fourteen subjects in each race were thus "paired off." These groups were compared with respect to median performances on all other tests used in the study. Inasmuch as the groups were small, and since the "pairing" resulted practically in a comparison of the lower 50% of the whites with the upper 50% of the Negroes, it is not deemed necessary to present a table with detailed comparative values. The essential results can be briefly summarized as follows: (1) the median IQ's of the two groups were approximately 86, (2) the Negro median exceeded that of the whites on all Rational Learning Test criteria except "rate of response," the differences in Q_w units being .75, 2.61, and 785 for time, errors, and trials, respectively, (3) the differences between the medians favored the Negroes in the case of five of the "speed" tests, the Q_w units were 55, 68, 1.09, .35, 1.68, for tapping, reading printed names, speed of movement, color naming, and cancellation, respectively; (4) the whites

excelled the Negroes in Rational Learning rate of response and Free Association, the difference in Q_w units being 1 00 and 68.

These results can have only limited significance, due both to the necessity of comparing the poorest whites with the best Negroes, and to the small number of cases In so far, however, as they mean anything, they indicate that when the differences in "intelligence" are thus controlled the "speed" differences favoring the whites disappear Indeed, the Negro is usually "faster" than the white of the same Stanford-Binet score.

d Differences in relative variability. Psychologists have long been intrigued by the notion that systematic variability differences exist in performances varying in complexity. Hollingworth in particular has emphasized a hierarchical organization of variability, acccording to which individuals differ more in complex than in simple traits (3, pp 74-78) Coefficients of variation have been computed for all tests used in the present study, both for the purpose of studying their possible bearing on this hypothesis and for comparing the variabilities of the two race groups We have mentioned already the possibility that the higher intercorrelation existing among the Negro test scores might conceivably have been due to their relatively greater heterogeneity Accordingly, the variability data are helpful in the general evaluation of the correlation results, as well as in comparing variabilities on different tests.

The variability comparisons are shown in Table 11. The first two columns contain the means and standard deviations of both race groups, the last two columns contain the "coefficients of variation" and the ratios of white to Negro variability The coefficient of variation is obviously an imperfect statistical value and its significance is especially questionable where so few cases are used The interpretations of the results in Table 11 should therefore be of a tentative nature But this value affords at least a clue to the status of variation in the present groups, regardless of what its representativeness might be with respect to larger groups

It is apparent from the last column in the table that no significant or consistent variability differences exist between the race groups The average of the ratios of white to Negro variability is .98 The whites are more variable on 5 of the 12 factors They are particularly more variable on the Stanford-Binet test, in striking contrast to the results of Peterson and Lanier with group intelligence tests of Nashville 12-year-olds (8, p 76) The latter investigators found

TABLE 11

COMPARISONS OF VARIABILITIES OF THE TWO RACES ON ALL TEST CRITERIA

The coefficients of variation (V) were derived by the formula $V=\sigma/\text{mean}$

	Test		Mean	Standard deviation	Coefficient of variation (V)	Variability of whites divided by variability of Negroes
1	Stanford-Binet mental age (mo)	W	143 3	21 95	153	
		N	117 2	16 20	138	1 11
2	Stanford-Binet IQ	W	96 56	14 55	151	
		N	78 00	10 90	140	1 08
3	Rational Learning time	W	13 46	7 40	550	
		N	17 07	11 02	646	85
4.	Rational Learning errors	W	118	89	754	
		N	136	101	742	1 02
5	Rational Learning trials	W	16 40	7.52	458	
		N	18 34	8 52	.465	98
6	Rational Learning rate of response	W	3 19"	702	220	
		N	3 84"	788	205	1 07
7	Minnesota Tapping	W	.426"	073	171	
		N	475"	095	191	.90
8	Naming names of colors	W	505"	148	293	
		N	620"	.207	334	.88
9	Minnesota Speed of Movement	W	245"	044	180	
		N	253"	049	194	93
10	Woodworth-Wells Color Naming	W	785"	169	215	
		N	908"	.194	214	1 01
11	Cancellation of A's	W	1 47"	307	.209	
		N	1 64"	345	210	.99
12	Free Association	W	2 80"	732	.261	
		N	3 45"	1 008	292	.89
	Average					98

the whites only half as variable as the Negroes on a Binet "group scale" and about 75% as variable on the Myers Mental Measure On the International Tests, their Nashville Negroes were more variable, although the difference was not as great as on the first-named test. In view of these conflicting results, and others which are apparent from a comparison of figures in their Table 25 with those in Table 11 here, it would seem that these variability "differences" are probably chance values dependent upon (1) the type of score unit, (2) whether or not a test has a time limit, (3) incidental fluctuations in sampling, etc These variability comparisons suggest that the higher average intercorrelation found for the Negroes can scarcely be due to their greater heterogeneity

The view that variation is greater the more complex the test receives little support from these results The performances which in the aggregate are presumably the most complex (Stanford-Binet) show the least variability, for both races. It is difficult to rate the other test factors with respect to complexity But if one rates them from "least variable" to "most variable" there is no suggestion of a hierarchical arrangement of the sort reported by Hollingworth. The greatest variability is found in the Rational Learning factors (except "speed"), which agrees with the results of Peterson and Lanier This fact gives a clue to the probable cause of the relative sizes of the coefficients of variation and tends also to lead one to question its significance. The Rational Learning Test has no time limit, with the result that time, trials, and errors influence the magnitude of the respective scores by cumulating directly with lack of success In a test like the Stanford-Binet, on the other hand, the units are less flexible and the total score less influenced by each single response of the subject. The age scale with its "all-or-none" system of scoring necessarily restricts the amount of variation which might occur It might be argued that the *relative* variation should not change with the score unit, since both average and standard deviation would be affected The point is that the standard deviation tends to be affected more than the arithmetic mean, with the result that a test which intrinsically involves greater numerical dispersion in indicating relative levels of performance will necessarily show greater relative variability This type of comparison would, then, appear to be very questionable, and it is by no means certain that data such as those presented by Hollingworth really mean what he claims It would seem that comparisons of different types

of tests with respect to relative variability could be made only after careful experimentation had established a valid basis for such comparisons. The nature of the sampling and the mechanical features of representing the performance ("scoring") can produce apparent differences in "variability" independent of any real difference in dispersion within a group due to the nature of the behavior Comparison of different groups, even race groups, as to variability of performance *on the same test* is less subject to criticism, although the causes of possible differences in relative variability are most difficult to discover.

Summary and Conclusions

The attempt has been made, both in the discussion of previous work and in the analysis of our results, to stress the need for careful analytical experimentation in the field of race psychology. The mere application of tests—particularly group tests, which in recent years have become favorite devices in race work—and uncritical "explanation" of the results in terms of heredity or environment are not only fruitless but are likely to be dangerous For one thing, these practices foster the delusion that a body of objective fact exists, whereas the "facts" are not facts at all in any meaningful, scientific sense This has been shown to be true specifically in the case of Klineberg's results (and conclusions) concerning "speed" and "accuracy." Both the "speed indices" and the "accuracy" scores used by him were found to be of highly questionable significance. And even if one granted that these scores represented definite aspects of performance, the generalization concerning "speed" from results for two performance tests (one of which has yielded a reliability coefficient as low as .22) is certainly of doubtful validity This generalization is strongly implied throughout Klineberg's discussion and is definitely made by Garth on the basis of Klineberg's conclusions. The implication is that the Negro inferiority on tests in which time either is a score or sets a limit to performance can be attributed to the fact that Negroes do not have the requisite "set" for speed. Yet their inferiority is greater on the Stanford-Binet test, which stresses speed hardly at all. But in this test, it might be said, there is an emphasis on language and the Negro's inferior educational status might result in a lower average performance in comparison with the white. This explanation is not satisfactory, however, when one notes that generally the Negro's performance on

non-linguistic "general intelligence" tests has been little better than on tests stressing language There remains a possible explanation in terms of "inferior" motivation in the Negro It might appear that the general conditions of Negro life would inevitably inculcate into him ineffectual habits with respect to perseverance, carefulness, sensitivity to the approval of others, etc., with the result that on a psychological test his performance would compare unfavorably with that of the white. Peterson and Lanier and also Klineberg have emphasized the possible importance of such circumstances (4, pp. 13-24, 8, pp 3-4) Although the effects of these rather intangible factors have not been demonstrated experimentally, nevertheless it would seem reasonable to believe that they exist. The results of the present study apparently show, however, that these conditions do not affect the Negro's relative standing in simple types of performance The Negro's motivation, sets for perseverance and speed, and other general factors often attributed to cultural background are adequate in the case of the simpler modes of behavior It is only when the situation becomes rather complicated that his inferiority is manifested This leads one to a rather curious impasse If these general factors are really general, it would seem that they should condition, with some degree of uniformity, all sorts of behavior Otherwise, one would have to postulate differential cultural conditions which affected motivation in relation to different orders of performance, a conceivable but hardly plausible view

The writers are not disposed to assert on the basis of these arguments that the differences found on the complex tests can be attributed exclusively to "heredity" They *believe* that innate organization is an important causal factor, but this opinion is tentative both as regards the existence and extent of this influence All of the environmental factors mentioned probably condition test performance, but the relative extent of their respective influences on various types of activities remains a problem for future research The foregoing considerations and the results of the present study should serve to emphasize the need for modesty and caution on the part of investigators who may have chanced upon a suggestive array of figures

The general significance of the specific experimental results of this study is, of course, problematical. The question of the extent to which these samplings represent the American Negro, and of the effects of race mixture on test performance in the "Negro" group,

for which no allowances can be made in our figures, suggest the appropriateness of reservations concerning the *general* meaning of our figures. With these qualifications the results of the study may now be summarized

1 The Stanford-Binet scale, a "rational learning" test, and six tests of rate of response were applied to 30 white and 30 Negro 12-year-old boys in certain Nashville, Tennessee, public schools. The median school grade of the whites was 6 75, while that of the Negroes was 5 60.

2. Intercorrelation among the 11 test criteria (4 of which were scores on the learning test) revealed markedly higher interrelationships among these factors in the case of the Negroes. Such a result suggests for the latter the greater operation of a common or general factor among the conditions determining performance on the several tests. A survey of the literature reveals that this result has been found before. Possible explanations are (1) greater heterogeneity in the Negro sampling, (2) the presumably more "diversified" environment of the white, and (3) the Negro might represent a more "primitive," less differentiated type of organization of behavior traits The hypothesis of the greater heterogeneity within the Negro group is not supported by comparisons of the coefficients of variation of the two races Whether or not either of the other two explanations is valid, or whether some other cause is responsible, cannot be decided from available data This problem is an important one for future research, not merely from the point of view of race psychology but from that of the psychology of human variability in general.

3. An enormous and statistically reliable difference favoring the whites was found in Stanford-Binet scores The median white IQ was 96, while that of the Negro was 77 5.

4 The three regular criteria of performance in the Rational Learning Test, total time, errors, and trials, yielded no statistically reliable race differences. The whites excelled in all three, the margin of difference being greatest for time The differences by the other criteria were very slight.

5 In rate of response ("speed index") on the Rational Learning Test, a very large difference in favor of the whites was found This result is attributed to the greater "responsiveness" of the whites to the situation of hearing the experimenter call out a letter and wait for a reply The whites seemed to reveal greater "social sensitivity," to be over-anxious, as indicated both by these figures and by

the experimenter's general impressions of the attituds of the two groups This "speed index" has little relationship to efficiency in the test, or to efficiency in any other tests used here

6 The results of the six direct tests of speed of reaction showed significant variations in the amounts of difference yielded No race difference at all was found in speed of simple manual movement. In reading typed names of colors, the whites were superior, although 43% of the Negroes exceeded the white average. These two tests were obviously the "simplest" used in the study The more complex tests, a category which might be said to include the other four, yielded much larger differences favoring the whites. An average of the percentages of whites surpassing the Negro medians on these tests was 77, while the corresponding average percentage for the Negroes was 27. Since the whites do not excel in speed in all types of processes, it is misleading to speak of "speed" differences in general It is even more misleading to make a gross interpretation of differences in "general intelligence" and "performance" test scores in terms of "speed." Klineberg's generalization, which states that the white superiority is confined to "speed" whereas in "accuracy" the races are about equal, is shown to rest upon inadequate primary data Furthermore, the results of the present study show that, even if his speed indices were significant for his tests, they could not apply to speed in all types of performances The term "speed" probably does not designate a unitary aspect or category of behavior, a conclusion supported both by the present data and by other results to be published elsewhere

7 Two groups, consisting of 14 subjects in each race, were equated for Stanford-Binet IQ and compared as to median performance on all other tests employed in the study The two groups consisted practically of the upper 50% of the Negro sampling and the lower 50% of the white The Negroes excelled the whites of equal Stanford-Binet average by 8 of the 10 criteria Only one of the differences was statistically reliable The whites were superior in Rational Learning "speed index," and in Free Association. These groups are too small to warrant a definite generalization from the results, although for these subjects the Negro of comparable Stanford-Binet rating—a rating not based upon "timed" performance—is as fast or faster than the white in the other activities studied

8 No significant race differences in variability were found on comparing the coefficients of variation Intra-race comparisons of

the relative variation on the several tests revealed no increase in variability corresponding to complexity of performance. It is suggested that the numerical unit used in "scoring" performance on a test influences this so-called "relative" variation index

References

1. BACHE, R. M Reaction time with reference to race *Psychol Rev.*, 1895, 2, 474-486.
2. GARTH, T R Race psychology New York Whittlesey House, 1931. Pp 260
3. HOLLINGWORTH, H L. Mental growth and decline New York Appleton, 1930. Pp 396.
4. KLINEBERG, O An experimental study of speed and other factors in "racial" differences *Arch Psychol*, 1928, 15, No 93 Pp 111.
5. LANIER, L H An analysis of thinking reactions of white and negro children. *J. Comp Psychol*, 1930, 10, 207-220
6. PETERSON, J The comparative abilities of white and negro children *Comp Psychol Monog*, 1923, 1, No. 5 Pp 141
7. ———, The use of a common unit in the measurement of race differences *Psychol Bull*, 1923, 20, 424-425
8. PETERSON, J, & LANIER, L H Studies in the comparative abilities of whites and negroes. *Ment Meas. Monog*, 1929, No 5. Pp 156
9. PETERSON, J, LANIER, L H., & WALKER, H. M Comparisons of white and negro children in certain ingenuity and speed tests *J Comp Psychol*, 1925, 5, 271-283
10. PETERSON, J, & TELFORD, C. W Results of group and of individual tests applied to the practically pure-blood negro children on St Helena Island *J Comp Psychol*, 1930, 11, 115-144.

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LES DIFFÉRENCES DE RACE DANS LA VITESSE DE LA RÉACTION

(Resumé)

On a pensé que les différences de race trouvés sur les tests psychologiques sont dues en grande partie à la vitesse supérieure des sujets de race blanche, qui dépassent d'ordinaire le rendement des autres races On a attribué ces différences de vitesse aux différences de milieu culturel. On analyse les résultats expérimentaux sur lesquels est basée cette opinion (pour la plupart ceux de Klineberg) et l'on montre que ceux-ci ne sont pas valables comme preuve de l'hypothèse La partie expérimentale de cette étude se compose de l'essai d'obtenir d'autres témoignages de fait sur cette question L'échelle Stanford-Binet, un test de "l'apprentissage rationnel" et six tests de "vitesse" de divers degrés de complexite ont été donnés à 30 garçons de race blanche agés de douze ans et à 30 garçons

nègres âgés de douze ans, à Nashville, Tennessee. Les comparaisons des résultats moyens selon la race ont indique que les blancs ont dépassé les nègres d'une façon marquée dans les types les plus complexes de rendement, tandis que dans les activites plus simples les races ont été presque égales en capacité Puisque l'on a trouvé la plus grande différence sur l'échelle Stanford-Binet, qui n'appuie guere sur la vitesse, tandis que dans les tests simples de vitesse mécanique les résultats moyens des races ont été à peu près égaux, on conclut que la théorie de la "différence de vitesse" est sans valeur et sans signification Dans les six tests de "vitesse" la supériorité de la race blanche tend à s'accroître avec la complexité du rendement, ce qui indique que la "vitesse" n'est pas une fonction de l'unité comme suggéré par l'usage de Klineberg Les inter-corrélations existant entre les tests ont été plus élevés pour les nègres que pour les blancs, qui indique possiblement un type moins différencié, plus primitif d'organisation mentale pour ceux-là.

LAMBETH ET LANIER

RASSENUNTERSCHIEDE IN BEZUG AUF SCHNELLIGKEIT DER REAKTIONEN

(Referat)

Es ist behauptet worden, dass die, an psychologischen Prufungen erwiesenen, Rassenunterschiede grossenteils durch die grossere Schnelligkeit der weissen Rasse, die in der Leistung gewohnlich andere Rassen ubertrifft, bedingt wird Die experimentellen Befunde, worauf diese Ansicht beruht (hauptsachlich die von Klineberg), werden analisiert, und es wird erwiesen, dass sie als Beweis fur die Hypothese nicht geltend sind Der experimentelle Teil dieser Untersuchung besteht aus einem Versuch, weitere faktische Daten zu dieser Frage zu sammeln Es wurden 30 weisse und 30 Neger-Jungen, alle 12 Jahre alt, in Nashville, Tennessee, gepruft mit der Testserie von Stanford-Binet, mit einem Test des "rationellen Lernens" ["rational learning" test], und mit sechs "Schnelligkeitsprufungen" ["speed" tests] die verschiedene Graden der Kompliziertheit aufwiesen Vergleichungen der Rassenunterschiede wiesen darauf hin, dass die Weissen den Negern in komplizierten Arten der Tatigkeit weit uberlegen waren, wahrend die zwei Rassen bei den einfacheren Arten der Tatigkeit ungefahr gleiche Tuchtigkeit erwiesen Daraus, dass sich in der Binet-Simon serie, in der die Schnelligkeit fast gar nicht betont wird, gerade die grossten Unterschiede zeigten, wahrend in den einfachen Prufungen der mekanischen Schnelligkeit die Rassendurchschnitte fast gleich waren, wird geschlossen, dass die Theorie des "Schnelligkeitsunterschiedes" sowohl ungultig wie sinnlos ist In den sechs "Schnelligkeitsprufungen" neigt die Überlegenheit der Weissen dazu, bei zunehmender Kompliziertheit der Tatigkeit zuzunehmen Diese Tendenz weist darauf hin, dass die "Schnelligkeit" keine einheitliche Funktion, wie sie Klineberg's Sprachgebrauch andeuten wurde, darstellt Die Korrelationen der einzelnen Tests unter einander waren bei den Negern hoher, als bei den Weissen Dieser Unterschied weist vielleicht auf eine weniger differenzierte, primitivere Art der geistigen Organisation bei den Negern hin

LAMBETH UND LANIER

THE MOTOR SPHERE OF SCHOOL-AGE CHILDREN*

From Bekhterev's Reflexological State Institute of Brain Researches, Leningrad

A. YARMOLENKO

In the scientific study of children many methods have been used by pedologists, a few have been taken over from psychology, psychiatry, and pediatrics, but most of them have been invented by the pedologists themselves For the most part study has been concerned with mental activity, and today it is fairly easy to measure mental ability, the development of speech, success in school work, etc. However, the motor responses of neither children nor adults have received a great deal of attention from experimentalists

The first step in our knowledge of the motor reaction was descriptive This can be seen in the old doctrine of the four temperaments, where the movements of the melancholic and phlegmatic are described as slow, the choleric as powerful and impulsive, and the sanguine as mobile and graceful. Later, from this doctrine, the descriptive schemes of movements were derived Only in the Twentieth Century did Homburger publish his well-known outline of age-motor development, which revealed the mechanisms of separate movements However, his differential motor diagnosis was still based on observation and may be expressed as follows: "The motor-gifted is a person who can use without effort for different spontaneous movements his motor equipment, helping himself by tools, and improving these movements by use of exercise. The motor-defective is a person who is unable to use his limbs, his static mechanisms, his voluntary innervation, and who is limited by a small number of simple motor actions."

The method recommended by Homburger for arriving at the motor diagnosis is "subtle observation and scrupulous description."

Gurewitch has offered a more extensive classification of movements as follows·

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1 Mechanisms governing the movements
2 Relation to external environment
   a. Defensive reflexes
   b Expressive movements
   c. Accompanying movements
   d Work-productive movements
3. Substance
   a. Energy, strength
   b Exactness of direction in space
   c. Successiveness in time, rhythm, fluency, gracefulness
4. Quality
   a Abundance or paucity of movements
   b. Duration and continuity of movements
   c. Simultaneous performance of some range of psycho-motor functions which were earlier automatized

Kirkpatrick divides the movements into the following types:

1 Automatic (breathing, digestion, blood circulation)
2. Reflexive (blinking, withdrawing the foot when pricked)
3 Instinctive (sucking, grasping)
4 Conscious (voluntary, spontaneous)

A complicated scheme of the phylogenesis of the entire motor sphere is given by D Smirnow:

1 Cell movements—amoeboid movements
2. Simple automatisms—simple reflexes—defensive reflexes—vegetative reflexes
3 Complicated automatisms and instinctive movements
4 Automatic movements, synergetic movements
5. Conditioned reflexive movements—complicated automatic and expressive movements
6 Voluntary movements—the working out of the motor formulae

Ontogenetically, these steps follow in order at birth the child possesses a wide range of movements representative of the first three groups The movements of the fourth group are of a transient character. Those of the fifth and sixth groups are acquired through the experience of the individual, although the tendency toward their development is hereditary

The appearance of all these classifications of movements marked the end of the unsystematic collection of material. The analysis

involved in the classifications opened the way for the construction of scales of motor tests. The first scale of this type was published by N. Ozeretsky in 1923. It was constructed on the same principle as the Binet-Simon scale, i e., it was a collection of separate tests or motor tasks ranked according to their "age difficulty" and rated alternatively, allowing the determination of a motor-age coefficient in relation to the chronological age At about the same time there appeared in America the Brace scale of motor development, which also gives a numerical motor coefficient.

The Bekhterev reflexological school bases its experiments on a typical display of human activity, i e., muscular movement An electrodermatic stimulus (the fundamental stimulus) is used to evoke the motor-defensive reaction. An indifferent stimulus (formerly associated with this fundamental stimulus, later given alone) provokes the same motor reaction In the investigation reported in this paper, using a word (a command or instruction) as the fundamental stimulus, we obtained as a response what might be called a socially conditioned motor response.

It is obvious that the objective study of human beings, either individually or in groups, cannot disregard the motor part of man's activity. The procedure for such study must lead toward the analysis of separate motor patterns and of their anatomical and physiological bases as well as toward the understanding of the ontogenesis and phylogenesis of the motor sphere as a whole. The latter is especially important in investigations of children, either individually or in groups.

The Laboratory of Age Reflexology of the Bekhterev Institute for Brain Research, aiming at the study of the correlative activity of the child, included in its plan of work the investigation of the motor sphere, i e, all motor acts, and patterns, and all the objective components of the motor sphere which can be correlated with the data of reflexological and biometric investigations

For this work it was necessary that we find a method which would give data which could be so correlated The alternative test, or even a variation of it (as used by Ozeretsky), did not meet our requirements, since it does not permit of arriving at a differential motor diagnosis It is not enough to say that a child's motor coefficient is normal for his chronological age, or that it surpasses it or does not reach it The data must be analyzable A method suggested by Dernowa-Yarmolenko seemed to meet our requirements

This method makes use of a group of mechanized motor patterns which are acquired in the life experience of the child A preschool child, a school-age child, an adult, a normal or a mentally defective child—even an imbecile—all these can walk, jump, grasp and relay objects, strike, lie down, throw a ball, etc Such activities make up the standardized tests of our general motor test. These movements are then analyzed into objective components which are expressed in figures, i.e , the speed, strength, and exactness of movement are scored. An individual is then scored according to his deviations from the norms for his age and sex.

Speed is scored by the amount of time spent on a given task For measuring strength, physical units are used, while exactness is measured by the number of mistakes (the failure to carry out instructions) Motor endurance (static and dynamic) and the average work tempo and its fluctuations are also measured.

Nine tests are proposed as follows

1. Speed and exactness.
   a Walking (the work of the lower extremities)
   b. Grasping and relaying objects (work of the upper extremities, right or left hand as preferred)
   c. Lying down and getting up (the work of the whole body)
2 Exactness in throwing a ball
3 Strength
   a Distance than can be jumped
   b Blow of the arm
   c. Heaviest weight that can be carried
4 Motor endurance·
   a. Static (length of time the subject can stand motionless with arms extended horizontally)
   b. Dynamic (number of jumps that subject can make on one leg)
5 Average tempo of work (jumping) and its tempo fluctuation expressed in a graphic curve

Any room with a sufficient amount of floor space can be used as the experimental room.

Measurements are secured on three patterns of walking (see Figure 1).

1 Walking on a straight line (drawn on the floor), 4 meters

long, which has 13 intersections dividing it into lengths corresponding to the average step of a child of school age.

2. Walking on the outline of a circle, the circumference of which measures 6 meters.

3. Walking on the outline of a square, 2 feet on a side

Each child is required to perform each of these walking tests four times, covering 72 meters in all. The time (in seconds) required for this performance is recorded, and the number of meters walked in one second is calculated for each individual. This figure gives us the *coefficient of walking-speed*

The total distance (72 meters) divided by the number of mistakes made in the test gives the number of meters covered with one mistake; this is known as the *coefficient of walking-exactness*

The grasping and relaying of objects is tested under the following conditions. The subject stands in front of a table the top of which is divided into two parts by a line On each half of the table top are the outline drawings of the following five objects; book, cup, weight, spoon, and pencil. The actual objects corresponding to these drawings must be moved from one set of figures to the other and back again, the actual object each time being placed on the corresponding outline. Time is taken and the number of movements performed in one minute is calculated, giving us a *coefficient of grasping-speed.* The number of mistakes gives the *measure of grasping-exactness.*

For the lying-down and rising test a small rug is spread on the floor The subject is required to lie down and get up three times. The record of the number of seconds allows us to calculate the number of such movements made in one minute—a *coefficient of lying-down-speed* The number of errors serves as a *measure of lying-down-exactness*

A small ball, 5 cm. in diameter, is used in the test of the accuracy of throwing. It is thrown at five circular targets, 45, 35, 25, 15, and 5 cm in diameter, respectively. The ball is thrown at a distance of 2 meters The number of times each of these targets is hit is recorded, and from these figures, with the aid of a special table (Table 1), a *coefficient of the exactness of throwing* is calculated.

The test of jumping is carried out over a row of numbered lines (20 cm apart) drawn on the floor. The *length of the jump* is measured by the number of the line that was reached

TABLE 1

FIGURES FOR THE SCORING OF THE BALL-THROWING TEST

Number of hits	Diameter of targets 45	35	25	15	5
1	2	3	4	6	18
2	3	4	5	9	27
3	4	5	7	12	36
4	5	7	9	16	48
5	10	13	18	30	90

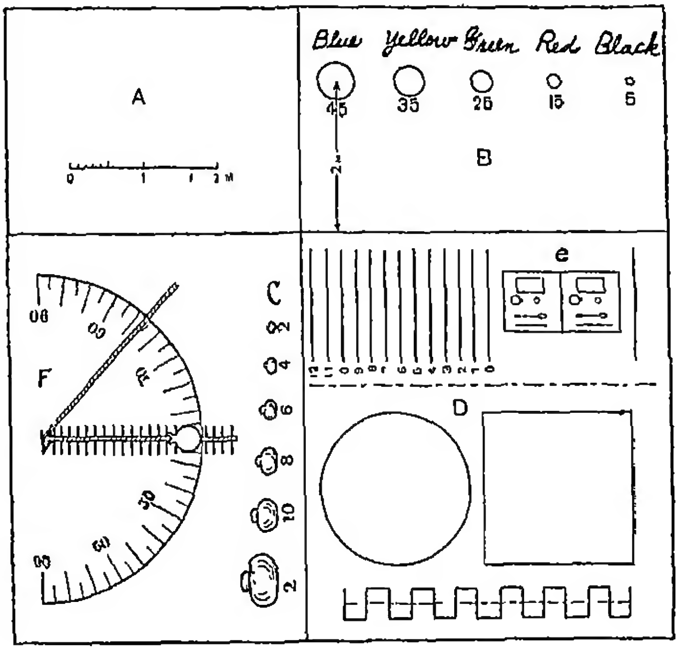


FIGURE 1

PLAN OF THE EXPERIMENTAL ROOM USED FOR THE MOTOR EXAMINATION

A—scale
B—targets
C—weights for transporting
D—outlines for walking test
E—table for grasping test
F—apparatus for testing strength of blow

TABLE 2

TABLE FOR SCORING THE ENERGY OF THE BLOW WITH DIFFERENT LENGTHS OF CORD (l) (IN CENTIMETERS) AND DIFFERENT ANGLES OF INCLINATION ($<\alpha$)
Weight (P)=2 kilos Energy of blow (E)=Pl (1—cos α).

α / l(cm)	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	α / l(cm)
90	0.7	2.7	6.1	10.9	16.9	24.1	52.6	42.1	52 7	64.5	76.8	90.0	103.9	118.4	133.4	148.7	164.3	180	90
95	0.7	2.9	6.5	11.5	17.8	25.5	54.4	44.5	55.7	67.9	81.5	95.0	109.7	125.0	140.8	159.0	173.4	190	95
100	0.8	3.0	6.6	12.1	18.7	26.3	36.2	46.8	58.6	71.4	85.3	100.0	115.5	131.6	148.2	165.3	182.6	200	100
105	0.8	3.2	7.2	12.7	19.4	28.1	38.0	49.1	60.6	75.0	89.5	105 0	121.2	138.2	155.6	173.5	191.7	210	105
110	0.9	3.3	7.5	13.3	20.6	29.5	39.8	51.5	64.4	78 6	93.6	110 0	127.0	144.8	163.1	181.8	200.8	220	110
115	0.9	3.5	7.84	13.9	21.5	30.8	41.6	53.8	67.4	82.2	98.1	115.0	132.8	151.3	170.5	190.1	210.0	230	115
120	1.0	3.6	8.2	14.5	22.5	32.2	43.4	56.2	70.3	85.7	102.3	120 0	138.6	157.9	177.9	198.3	219.1	240	120
125	1.0	3.8	8.5	15 1	23.4	33.5	45.2	58.5	73.2	89.3	106.6	125.0	144 3	164.5	185.3	207.6	228 2	250	125
130	1.0	3.9	8.9	15.7	24.4	34.8	47.0	60.8	76 2	92 9	110.9	130.0	150.1	171.1	192.7	214 9	237.3	260	130
135	1.0	4.1	9.2	16.3	25.3	36.2	48.8	63.2	79.1	96.4	115.1	135.0	155.9	177.7	200.1	225.1	246.5	270	135
140	1.1	4.3	9.5	16.9	26.2	37.5	50.6	65.5	82.0	100.0	119.4	140.0	161.7	184 2	207.5	231.4	255.6	280	140
145	1.1	4.4	9.9	17.5	27.2	38.9	52.4	67.8	84.9	103.6	123.7	145.0	167 4	190 8	214.9	239.6	264.7	290	145
150	1.1	4.6	10.2	18.1	28.1	40.2	54.3	70.2	87.9	107.2	127.9	150.0	173.2	197.4	222.4	247.1	275.9	300	150
155	1.2	4.7	10.6	18.7	29.0	41.5	56.1	72.5	90.8	110.7	132.2	155.0	179.0	203.9	229.8	256.1	282.0	310	155
160	1.2	4.9	10.9	19.3	30.0	42.9	57.9	74.9	93.3	114.3	136.5	160.0	184.8	210.6	237.2	264.4	292.1	320	160
165	1.3	5.0	11.2	19.9	30.9	44.2	59.7	77.2	96.7	117.9	140.7	165.0	190.5	217.1	244.6	272.7	301.2	330	165
170	1.3	5.2	11.6	20.5	31.9	45.5	61.5	79.5	99.6	121.5	145 0	170.0	196.3	223.7	252.0	280.4	310.4	340	170
175	1.3	5.3	11.9	21.1	32.8	46.9	63.3	81.9	102.5	125.0	149.2	175.0	202.1	230.0	259.4	289.2	319 5	350	175
180	1.4	5.5	12.2	21.7	33.7	48.2	65.1	84.2	105.4	128.6	153.5	180.0	207.9	236.9	266.8	297.6	328.6	360	180
185	1.4	5.6	12.6	22.3	34.7	49.6	66.9	86.6	108.4	132.2	157.8	185.0	213.6	243 5	274.2	305.7	337.7	370	185
190	1.4	5.8	13.0	22.9	35.6	50.9	68.7	88.9	111.3	135.7	162.0	190.0	219.4	250.0	281.7	314.0	346.9	380	190
195	1.5	5.9	13.3	23.5	36.5	52.2	70.5	91.2	114.2	139.3	166.3	195.0	225.2	256 6	283.1	322 3	356.0	390	195
200	1.5	6.0	13.6	24.1	37.5	53.6	72.4	93.6	117.2	142.8	173.6	200.0	231.0	263.2	296 5	330.5	365.1	400	200
205	1.6	6.2	14.0	24.7	38.4	54.9	74 1	95.9	120.1	146.5	174.8	205.0	236.7	269.8	305.9	338.8	374.3	410	205

In measuring the strength of the blow a suspended football filled with sand, weighing 2 kilos, is used The ball hangs from a block in the middle of a semicircular frame on which degree measurements are indicated (see Figure 1), permitting us to record figures from which to calculate the strength of the blow delivered by the subject (when we have taken into account the length of the cord on which the ball is suspended) The measurement is expressed in kilo-centimeters and is calculated from a special table (Table 2).

The *coefficient of transported weight*, expressed in kilos, is obtained by taking the numerical value of the heaviest weight that can be carried a distance of 4 meters by the subject

The number of jumps which the subject can make on one leg (without touching the other to the ground) gives us the *coefficient of dynamic endurance*. From this test is also secured the *measure of the average muscular work-tempo* and its fluctuations.

The number of minutes during which the child can stand motionless with his arms stretched out horizontally supplies the *coefficient of static endurance*

The examination is given as a group experiment, usually to four or five children at a time, preferably those from one home, one school class, or similar group This is done because it seems best to keep the conditions as natural as possible Children usually engage in such activities in groups, also, the factors of imitation and rivalry are such natural parts of activity of the sort that we are testing that it seems best to allow them to operate in the test conditions

The data which we wish to report in this paper were secured from a group of school children between the ages of 8 and 15 years. They may be grouped according to their age and sex into 14 groups, 30 children in each group Because of the smallness of the groups and the selection which occurred it has been necessary to resort to the method of interpolation to supplement the empirical data in the tables which we present

The following measures were calculated for each group and for each measure mean (M), average error (m), and standard deviation (σ) The complete data, including interpolations, are given in Tables 3-6 and Figures 2-6.

Examination of these tables and figures shows a number of interesting facts:

TABLE 3

SEX-AGE MOTOR COEFFICIENTS OF SPEED AND STRENGTH FOR GIRLS

Age from-to-	Age	Speed									Strength									Age	Age from-to-
		Walking			Grasping			Lying			Spring			Blow			Transporting				
		M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m		
15-14	14 5	58 0	9.44	1.78	44.1	9 03	1.24	149	34.7	6.18	145	20 3	3 12	77 3	41.2	3.0	26.5	5 3	1 0	14 5	14-15
	14	57.8			44.1			150			144			73.8			25.9			14	
14-13	13.5	57 2	9 21	1.69	43 9	9 98	1 44	151	34 6	6.90	144	22 0	4 72	68 3	55.7	3 9	24 9	4 9	0 9	13 5	13-14
	13	56 3			43.5			151			142			61.5			25.4			13	
13-12	12 5	55 0	8.97	1 58	42 7	11 50	1 59	151	34 1	5 77	139	23 2	3 98	54 2	26 6	3 6	22 0	4 4	0 8	12 5	12-13
	12	55 3			41.4			150			135			47 3			20 3			12	
12-11	11.5	51 2	8 89	1 61	39.7	12.83	1 96	148	34 0	5 75	130	22.6	4 82	41.2	18 8	3.4	18.8	3.9	0 7	11 5	11-12
	11	48.9			37 8			145			124			36 3			17 6			11	
11-10	10 5	46 7	8.92	1 68	35 8	13 56	2 43	143	35 5	6 08	119	21 7	3 18	32 6	15.6	2 1	16 5	3 4	0 6	10 5	10-11
	10	44 6			34.2			141			114			50 4			15 8			10	
10-9	9 5	42 8	9.07	1 48	32 9	14.25	3 13	139	38 8	5 78	109	22.3	3 65	29 2	16 2	2 9	15 5	3 1	0 5	9 5	9-10
	9	41 4			32 0			138			106			29 0			14.9			9	
9-8	8 5	40 4	9 29	1.73	31 5	15 06	2 93	137	41 8	5 04	104	23 9	4 85	29 1	17 7	3 5	14 6	3 0	0 5	8 5	8-9

TABLE 4

SEX-AGE MOTOR COEFFICIENTS OF SPEED AND STRENGTH FOR BOYS

Age from–to–	Age	Speed									Strength									Age	Age from–to–
		Walking			Grasping			Lying			Spring			Blow			Transporting				
		M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m		
15–14	14.5	66.5	10.44	1.96	44.0	9.01	1.73	175.0	34.1	4.30	150	24.1	4.61	108.0	43.4	5.7	34.6	7.8	0.9	14.5	14–15
	14	65.7			43.7			172.8			148			105.9			33.7			14	
14–13	13.5	64.5	10.55	1.74	43.0	8.87	1.48	169.7	31.6	4.46	146	24.3	3.20	103.3	41.4	5.5	32.4	7.0	1.0	13.5	13–14
	13	63.1			42.2			166.4			144			98.7			30.7			13	
13–12	12.5	61.4	10.84	2.04	41.0	10.03	1.59	163.1	31.1	5.32	141	24.5	3.79	92.5	37.8	6.8	28.8	6.6	1.0	12.5	12–13
	12	59.3			39.5			160.0			139			84.2			26.9			12	
12–11	11.5	56.8	10.66	1.22	37.8	12.86	1.66	156.8	33.1	4.85	137	23.0	3.37	75.5	33.5	4.3	24.9	6.5	1.6	11.5	11–12
	11	54.1			35.9			153.2			134			67.2			23.0			11	
11–10	10.5	51.4	9.80	1.74	34.0	15.00	1.44	149.2	35.6	5.02	130	20.3	3.81	59.8	30.1	6.4	21.2	5.7	1.0	10.5	10–11
	10	48.9			32.2			144.8			127			53.8			19.4			10	
10–9	9.5	46.7	8.88	1.28	30.7	14.91	1.75	140.4	35.7	4.97	123	20.1	5.04	49.1	25.6	5.1	17.9	4.4	1.0	9.5	9–10
	9	45.2			29.5			136.3			120			45.6			16.7			9	
9–8	8.5	44.2	8.77	1.69	28.9	14.04	1.65	133.5	33.2	4.21	119	22.4	5.18	43.4	25.2	3.3	15.9	5.5	0.7	8.5	8–9

The evolution of motor activity between the ages of 8 and 15 years shows three definite stages: in the ninth and tenth years there is a negative acceleration in development, from 10 to 12 for girls, and from 10 to 13 for boys, a positive acceleration is shown; while with the approaching of puberty there is a second period of retarded development, whch is more evident in girls than in boys

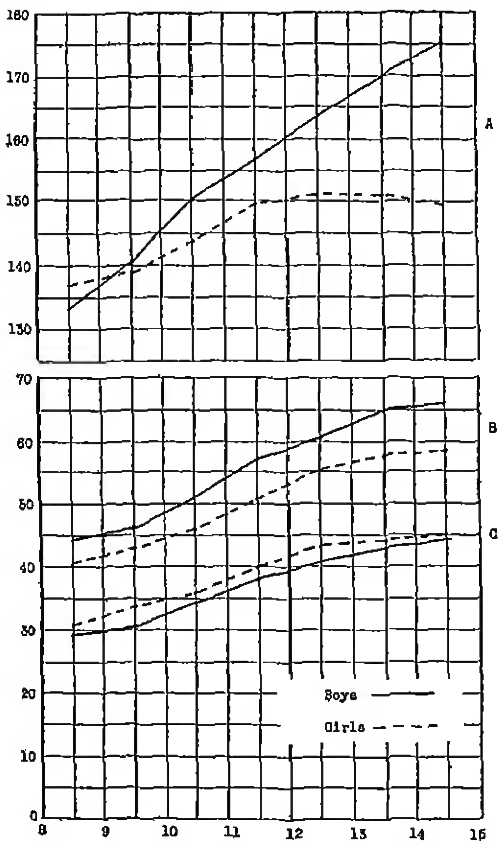


FIGURE 2

SPEED COEFFICIENTS

A—lying-rising (number of movements in 10′)
B—walking (number of meters walked in 1′)
C—grasping (number of movements in 10′)

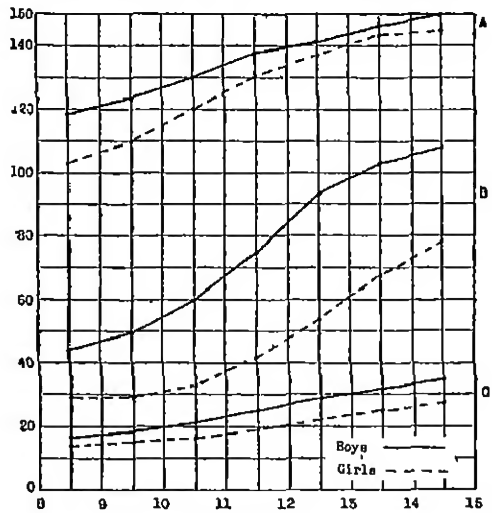


FIGURE 3

STRENGTH COEFFICIENTS

A—spring (length in cm)
B—blow (strength in kcm)
C—transported weight (in kilos)

The measures of strength and speed (Tables 3 and 4, Figures 2 and 3) show these three phases of development, as do also the coefficients of dynamic endurance (Tables 5 and 6; Figure 4, *B*) The sex curves for static endurance differ—that for the boys shows the three phases, whereas that for the girls shows a definite fall from 13 to 15 from a rather constant level maintained from 8 to 12 years (Figure 4, *A*). The curves for exactness rise very regularly, showing little influence of puberty (Tables 5 and 6, Figure 5)

In the speed of walking, boys surpass girls at all ages (Tables 3 and 4, Figure 2, *B*). In lying down and rising, at the ninth year the girls surpass the boys, then the age curves cross each other and show a progressive divergence (Tables 3 and 4, Figure 2, *A*). The extreme divergence at the 15th year may be explained by the unequal influence of puberty on girls and boys. The coefficients of the speed of grasping are higher at all ages for girls than for boys (Tables 3 and 4; Figures 2, *C*). It may be noted that the three last-mentioned measures show a relationship between

TABLE 5

SEX-AGE MOTOR COEFFICIENTS OF EXACTNESS, TEMPO, AND ENDURANCE FOR BOYS

Age from-to-	Age	Exactness												Tempo of Jumps			Endurance						Age	Age from-to-
		Walking			Grasping			Lying			Throwing						Dynamic			Static				
		M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m		
15-14	14.5	19.1	3.4	0.6	0.60	0.30	0.11	0.78	0.40	0.14	12.51	5.88	1.16	2.50	0.41	0.08	406	147	14	6.25	3.83	0.75	14.5	15-14
	14	18.8			0.70			0.80			12.07			2.53			416			6.33			14	
14-13	13.5	18.3	2.8	0.8	0.78	0.53	0.17	0.81	0.44	0.15	11.52	5.35	1.00	2.57	0.59	0.07	422	110	9	6.40	3.98	0.48	13.5	14-13
	13	18.0			0.87			0.82			10.76			2.61			414			6.42			13	
13-12	12.5	17.7	2.5	0.5	0.94	0.63	0.18	0.83	0.55	0.15	10.08	4.67	0.77	2.64	0.38	0.06	391	90	6	6.37	3.96	0.81	12.5	13-12
	12	17.2			0.98			0.85			9.46			2.65			354			6.28			12	
12-11	11.5	16.8	2.8	0.5	1.02	0.67	0.25	0.90	0.61	0.17	8.87	4.17	0.75	2.65	0.37	0.08	311	88	18	6.13	3.69	0.77	11.5	12-11
	11	15.9			1.16			0.96			8.32			2.65			271			5.96			11	
11-10	10.5	15.1	3.8	1.4	1.32	0.97	0.27	1.03	0.65	0.18	7.79	3.80	0.72	2.65	0.37	0.06	234	76	4	5.72	3.34	0.65	10.5	11-10
	10	14.5			1.44			1.07			7.30			2.66			264			5.41			10	
10-9	9.5	13.1	5.4	0.9	1.56	1.37	0.28	1.12	0.68	0.19	6.87	3.43	0.61	2.66	0.37	0.08	178	56	14	5.05	2.92	0.68	9.5	10-9
	9	12.2			1.71			1.15			6.53			2.67			157			4.69			9	
9-8	8.5	11.3	5.7	1.0	1.96	1.59	0.34	1.18	0.73	0.20	6.31	3.15	0.51	2.69	0.36	0.06	243	53	11	4.41	2.53	0.89	8.5	9-8

TABLE 6

SEX-AGE MOTOR COEFFICIENTS OF EXACTNESS, TEMPO, AND ENDURANCE FOR GIRLS

Age from-to-	Age	Exactness												Tempo of jumps			Endurance						Age	Age from-to-
		Walking			Grasping			Lying			Throwing						Dynamic			Static				
		M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m	M	σ	m		
15–14	14.5	20.1	2.4	0.4	0.58	0.27	0.1	0.54	0.25	0.1	9.22	4.05	0.81	2.59	0.33	0.05	326	307	19	5.13	3.61	0.67	14.5	15–14
	14	19.9			0.63			0.58			9.06			2.61			329			5.34			14	
14–13	13.5	19.6	2.3	0.5	0.67	0.40	0.1	0.63	0.29	0.1	8.81	3.93	0.63	2.62	0.34	0.09	328	339	14	5.60	4.02	0.78	13.5	14–13
	13	19.1			0.79			0.67			8.51			2.62			319			5.80			13	
13–12	12.5	18.4	3.8	0.7	0.89	0.62	0.1	0.70	0.38	0.1	8.18	3.99	0.68	2.61	0.34	0.05	301	306	22	5.93	4.28	0.86	12.5	13–12
	12	17.8			0.99			0.76			7.75			2.59			275			5.93			12	
12–11	11.5	17.2	3.7	0.7	1.07	0.97	0.2	0.81	0.41	0.2	7.53	4.25	0.78	2.58	0.32	0.07	248	217	18	5.89	4.32	0.67	11.5	12–11
	11	16.4			1.16			0.91			7.25			2.56			222			5.85			11	
11–10	10.5	15.8	3.5	0.8	1.23	1.10	0.2	1.02	0.58	0.2	6.92	4.37	0.88	2.54	0.30	0.06	201	146	19	5.83	4.49	0.65	10.5	11–10
	10	14.8			1.57			1.06			6.60			2.52			185			5.82			10	
10–9	9.5	13.9	3.5	1.2	1.50	1.12	0.3	1.09	0.63	0.2	6.30	4.25	0.70	2.50	0.27	0.04	173	115	20	5.80	4.66	0.78	9.5	10–9
	9	12.2			1.60			1.10			6.02			2.49			165			5.70			9	
9–8	8.5	11.5	4.0	1.2	1.66	1.10	0.3	1.10	0.61	0.2	5.83	4.08	0.81	2.48	0.25	0.05	160	107	18	5.61	4.58	0.75	8.5	9–8

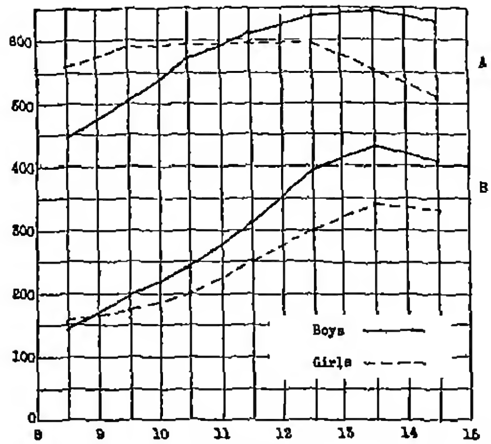


FIGURE 4

ENDURANCE COEFFICIENTS

A—static endurance (in 0.01')
B—dynamic endurance (in number of jumps)

the sexes which might have been expected: The girls excel in the activity that requires the use of the finer coordinations, while the boys excel in those which require the grosser movements.

In the measures of exactness of movements, girls surpass the boys in three tests: walking, lying down, and grasping However, in the accurate throwing of a ball boys surpass girls at all ages, the difference between the curves increasing with age. (See Tables 5 and 6, and Figure 5.)

All three measures of strength show a superiority of the boys which increases with age (Tables 3 and 4, Figure 3)

The average rate (tempo of jumps) curves cross each other at 12 years, the girls' rate increasing at that age, while the boys' rate decreases (Figure 6) Girls are superior to boys on the dynamic endurance test only at the ninth year (Figure 4, *B*) The curves for static endurance also cross, that for the girls falling and that for the boys rising (Figure 4, *A*).

Summarizing the relations between the age curves of the sexes, we may say that the boys' coefficients of speed of walking, speed of lying down, all three coefficients of strength, that of exactness of ball-throwing, and that of dynamic endurance surpass those of

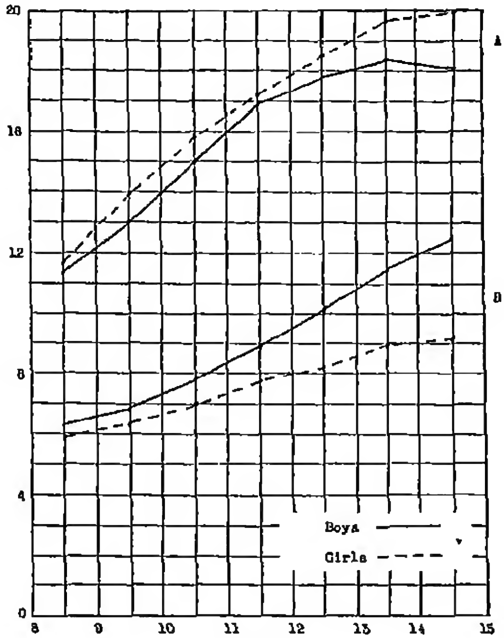


FIGURE 5
EXACTNESS COEFFICIENTS
A—exactness of walking (number of meters with one mistake)
B—exactness of ball-throwing

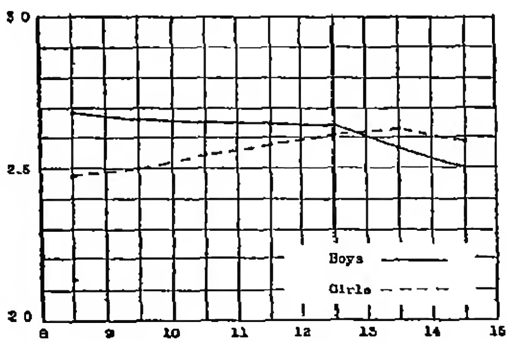


FIGURE 6
TEMPO COEFFICIENTS
Average number of jumps per second

the girls, -0.5σ for boys corresponds to $+0.5\sigma$ for girls. The opposite relationship is found with the measures for the speed of grasping and for exactness in walking, grasping, and lying down. The curves for the rate of work (jumping on one foot) and for static endurance cross, i.e., each sex excels for a part of the seven-year period.

Our subjects are in the third period of Homburger's grouping, the period of formation of the psycho-motor apparatus, just ready to enter into the pubertal period, which was characterized by Homburger by awkwardness, superfluous movements, and the lack of inhibition. He explains the general motor state by the retarded development of the central apparatus, which lags behind the peripheral apparatus, destroying the general order of functioning of the latter. Our results show the influence of the pubertal period, slowing up the increase of coefficients, and in some cases actually decreasing them

The retardation of motor development during the ninth and tenth years can be explained by some of our other experimental data which show the unusual development between the fifth and eighth years, the later retardation may be a reaction to that rapid development From 11 to 13 there is another spurt in development. This is the pre-pubertal period and is a period of quick, many-sided development, which changes with the onset of puberty

After working out the sex-age distributions of the motor coefficients, motor profiles are constructed in conformity with the method used in constructing the anthropometrical profiles which are widely used at the present time. Thirteen values are used: 3 speed measures, 4 exactness measures, 3 of strength, 1 of rate, and 2 of motor endurance Means and sigmas are calculated for each measure and a profile card constructed for each age and each sex, 14 in all With these as a basis, the individual and group profiles are drawn

Group profiles are considered normal if the profiles fall between $\pm 0.5\sigma$ (or less if the group consists of more than 50 children) Individual profiles are rated as normal if all points fall between $\pm 1\sigma$

Figure 7 shows the profiles (*a*) of an imbecile boy, (*b*) of a boy from a normal school, and (*c*) of a motor-gifted girl from a rhythmic studio The motor characteristics of each of these individuals may be seen readily by considering first the general height (H) of

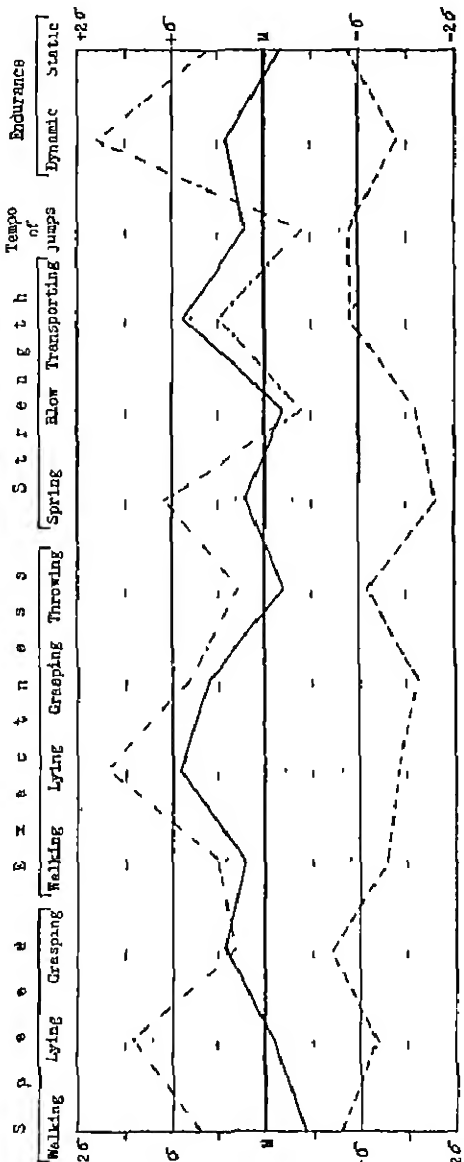
FIGURE 7

INDIVIDUAL MOTOR PROFILES

- - - - - - (a) profile of an imbecile boy—H=—1 1σ

———— (b) profile of a normal boy—H=+2σ

—·—·— (c) profile of a motor-gifted girl—H=+7σ



the profile, i.e., the mean obtained from the sigma deviations on all the components of the profile, and, secondly, by the heights of each coefficient-group, i.e., speed, exactness, strength, tempo, and motor endurance. Thus the mentally defective child has the lowest standing in exactness, endurance, and speed, with comparatively normal strength, all deviations together giving an H of -1.1σ The fluctuations of the normal boy's profile are insignificant, and his H of $+0.2\sigma$ lies very near M, the mean. The profile of the motor-gifted girl shows a high standing on exactness and endurance, the H of $+0.7\sigma$ places her at nearly one sigma above the mean.

The deviations of the group-coefficients are rather definite for different types of defective children and show a characteristic motor profile for the psychoneurotics, the blind, the deaf and dumb, etc. This problem we have discussed elsewhere, however, and we will therefore not consider it further at this time.

Summary

In summary we might say that the proposed method of investigation of life-essential movements and the resultant motor profiles makes possible (1) the determination of the level of the child's motor development much the same as other methods have made possible the determination of the child's mental level; (2) the correction and development of motor ability through diagnostic use of the profiles, and (3) the scoring, i.e., actual measurement, of such improvement as the result of pedagogical work.

P. Lesgaft has stated the purpose of physical education as. "bringing the nervous system to such a state that a maximum quantity of its best work can be performed with a maxmium speed and a minimum expenditure of strength." The *best* work of a given child, i e, that which his system is capable of producing, can be determined only experimentally, this explains the modern tendency to adopt the methods of motor investigation in pedological practice. In practical life the immediate examination of the results are obtained and fixed

Bekhterev's Reflexological State
Institute of Brain Researches
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LA SPHÈRE MOTRICE DES ENFANTS D'ÂGE SCOLAIRE

(Résumé)

Cette étude du développement moteur des enfants âgés de 8 à 15 ans a été faite selon une methode suggérée par A Dernowa-Yarmolenko, laquelle se compose d'évaluer divers mouvements "essentiels a la vie" On obtient des mesures des composantes suivantes (1) la vitesse de la marche, (2) l'exactitude de la marche, (3) la vitesse de prendre et de passer des objects, (4) l'exactitude de prendre et de passer des objets, (5) la vitesse de se coucher et de se lever, (6) l'exactitude de se coucher et de se lever, (7) l'exactitude de jeter une balle, (8) la longueur du saut, (9) la force d'un coup, (10) la mesure du plus lourd poids qu'on puisse porter, (11) la durée du temps que le sujet peut se tenir debout sans motion les bras étendus horizontalement (endurance statique), (12) le nombre de sauts sur une jambe (endurance dynamique), et (13) la vitesse moyenne du travail (la vitesse des sauts sur une jambe)

Les données obtenues de l'examen d'une population scolaire normale (âges 8-15, 30 garçons et 30 filles dans chaque groupe de chaque âge), avec quelques interpolations, sont présentées en forme de tableaux et en forme graphique, fournissant les moyennes, les erreurs moyennes, et les écarts étalons (σ's) pour chaque âge et chaque sexe pour chaque composante Les moyennes et les σ's sont aussi employées pour former la base pour la construction des profils individuels qui correspondent aux profils anthropométriques qui sont beaucoup employes a présent.

Le profil moteur le rend possible de déterminer le type moteur et la position motrice relative d'un enfant ainsi qu'un don moteur quelconque ou un défaut moteur quelconque.

YARMOLENKO

DER MOTORISCHE WIRKUNGSKREIS SCHULPFLICHTIGER KINDER

(Referat)

Diese Untersuchung der motorischen Entwicklung von Kindern im Alter zwischen 8 und 15 Jahren wurde mit einer Methode ausgeführt, die von A. Dernowa-Yarmolenko vorgeschlagen wurde und die aus der Bewertung verschiedener "lebenswesentlicher" Bewegungen besteht Es wurden Messungen angestellt an folgenden Tatigkeiten (1) Schnelligkeit des Gehens, (2) Genauigkeit des Gehens, (3) Schnelligkeit des Greifens, (4) Genauigkeit des Ergreifens und des Weitergebens (relaying) von Gegenstanden, (5) Schnelligkeit des Sich-Niederlegens und des Aufstehens, (6) Genauigkeit des Sich-Niederlegens und des Aufstehens, (7) Genauigkeit beim Werfen eines Balles, (8) Lange des Sprunges, (9) Starke eines Faustschlages, (10) Mass des schwersten Gewichtes, das gehoben werden kann, (11) Zeit wahrend der die Versuchsperson bewegungslos mit horizontal ausgestreckten Armen stehen bleiben kann (statische Ausdauer), (12) Zahl der Sprunge auf einem Bein (dynamische Ausdauer), und (13) durchschnittliche Schnelligkeit bei der Tatigkeit (Schnelligkeit [rate] des Springens auf einem Bein)

Die durch die Untersuchung der Mitglieder einer regelmassigen [normal] Schulgemeinde erhaltenen Befunde (an je 30 Knaben und 30 Mad-

chen aus jeder Jahrgruppe im Alter 8 bis 15, werden mit einigen Interpolierungen in tabularischer und in graphischer Form angegeben. Auf diese Weise werden uns fur jedes Alter und fur beide Geschlechter in Bezug auf jeden Bestandteil der Prufungen Durchschnittszahlen, durchschnittliche Fehler, und Normalabweichungen (σ's) zur Verfugung gestellt Die Durchschnittszahlen und Normalabweichungen verwendet man auch als Basis zur Konstituirung individueller Profile den anthropometrischen Profilen entsprechend, die heutzutage weitlaufig gebraucht werden

Das motorische Profil ermoglicht die Bestimmung des motorischen Typus und der relativen motorischen Stellung des Kindes, wie auch einer etwaigen motorischen Begabung oder eines motorischen Manges

YARMOLENKO

THE FUNDAMENTALS OF A METHOD OF INVESTIGATING THE FUNCTION OF THE NERVOUS SYSTEM AS REVEALED IN OVERT BEHAVIOR*

From the Leningrad Institute of Child and Youth Health Care

A. A. Dernowa-Yarmolenko

The Leningrad Institute of Child and Youth Health Care started its task with the problem of finding a method by which it would be possible to determine the age and sex characteristics of the functioning of the nervous system in relation to the regulation of behavior. One of the chief difficulties of this problem lay in the fact that the experimental session had to be kept short enough not to interfere with the work of the other laboratories through which the child had to pass in the course of his regular examination (anthropometrical, pediatric, etc.). The time was arbitrarily fixed at a quarter of an hour, which is a very short period for experimental work. Only in rare cases were repeated examinations possible.

Since we were interested in the mechanism of the nervous system as the basis of child behavior, our method was necessarily concerned with the overt behavior of the organism and, consequently, with the activity of the neuromuscular equipment. Therefore Pavlov's method, which deals with secretory activity, could not be used. We know today that in human beings the so-called fundamental reflexes,[1] i.e., the defensive, nutritive, and sexual, have undergone a complete change because of social factors. They are socially inhibited; even a small child does not take sweets without a verbal disinhibition in the form of "you may," "take it," etc. Because of this social conditioning it seems that the muscular reaction in connection with a verbal instruction, as "previously conditioned behavior," is better suited for experimentation on human beings, even with children, in order to throw light on the function of the brain hemispheres. Therefore, the method of using a verbal stimulus† (instruction or order) in

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[1]Called fundamental by Bekhterev, unconditioned by Pavlov.

†Editorial note: "Stimulus" has been substituted for the word "irritator" which was used in the translation submitted by the author.—L. Harden.

association with a muscular reaction has been adopted in reflexological examination of children in the Bekhterev Institute for Brain Researches in Leningrad The experimental method used in the study which is described in this paper is based on that principle

The tap of a pencil on the table was chosen as the associated (accompanying) stimulus, the sound of a tap being a common auditory stimulus in everyday life Musical sounds, such as the ringing of a bell, or even a squeak may evoke orientative reactions of a particu-

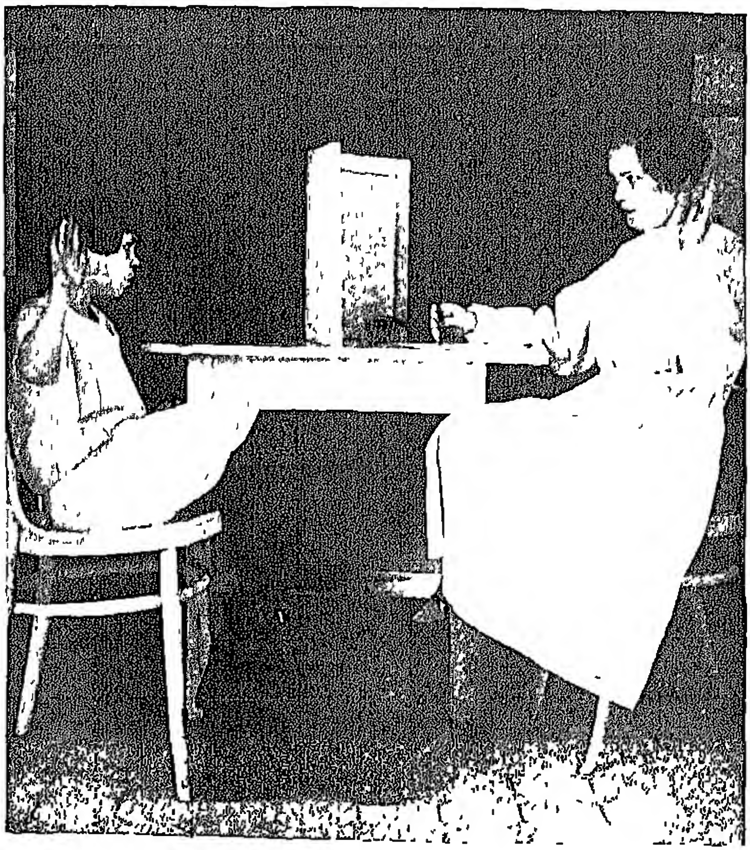

FIGURE 1
PHOTOGRAPH SHOWING THE SET-UP FOR THE REFLEXOLOGICAL EXAMINATION

lar character, a fact which may complicate the response reactions. Our method enabled us to work without any special apparatus

Figure 1 shows the general experimental set-up The examiner sits at a small table The child who is being tested sits facing the examiner, but a little to the left of the table The child's position is determined by that of the examiner, i.e., one leg is swung over the other, the child's right hand rests on his knee. If the child is small, a foot-stool is put under his feet to give him the proper support.

The record sheet, as well as the experimenter's right hand, is hidden from the child's view by a screen or by a large book standing open on the table. This makes it impossible for the child to see the movements of the examiner's hand in taking the records and in tapping the pencil on the table When the child is seated in the chair in the required position, the examiner says, "Look at me and do what I do." He then waits a certain number of seconds, as shown on the record sheet (see plan of record sheet shown as Figure 2),[2] and the experiment begins It involves the following details. (*a*) a tap of the pencil on the table (behind the screen), (*b*) a two-second pause, and (*c*) the examiner's lifting his hand to a level with his head and holding it there for three seconds

This association is thus given: the tap of the pencil and the lifting of the hand after the lapse of two seconds The child, following the instructions given him, also lifts his hand. This combination of stimuli is repeated ten times

If the child lifts his hand following the tap, before the examiner has lifted his hand,[3] a minus sign is put in the appropriate place on the record sheet If the child lifts his hand only after the examiner has lifted his, a plus sign is entered

Immediately after the ten repetitions of the tap–raising-the-hand association (raising the hand being hereafter spoken of as the *first pattern*), testing with another pattern follows. This *second pattern* is the spoken sound "ai." The test is scored in the same way as the first The *third pattern* is a tap of the foot, the procedure of the test and of the scoring remain the same

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[2]The numbers on the left side of the record sheet show the time in seconds which must elapse before the stimulus is given

[3]The two-second interval between the tap and the raising of the hand by the examiner is given to allow for this to happen After the lapse of two seconds, whether or not the child has responded, the examiner gives the pattern, i.e., raises his hand

RECORD SHEET FOR THE REFLEXOLOGICAL EXAMINATION

Name ______________ Surname ____________________ Age ______

Institution ________________ Form ______________ Date _____

(Part I) (Part II) No. ____

15	1			1	2	3	
10	1			1	2	3	a
20	1			1	2	3	
5	1			1	2	3	
10	1			-	2	3	
25	1			-	2	3	b
10	1			-	2	3	
15	1			1	2	3	c
5	1			1	2	3	
20	1			1	-	3	
10		2		1	-	3	d
25		2		1	-	3	
5		2		1	2	3	e
15		2		1	2	3	
10		2		1	2	-	
25		2		1	2	-	f
5		2		1	2	-	
15		2		-	-	3	
10		2		1	-	-	g
20		2		-	2	-	
15			3				
5			3				
10			3				
25			3				
10			3				
15			3				
5			3				
20			3				
10			3				
25			3				

FIGURE 2

RECORD SHEET FOR THE REFLEXOLOGICAL EXAMINATION

Editorial note The headings have, of course, been translated, and this reproduction is of a typewritten form prepared in the editorial office. The handwritten additions were also made in this office to facilitate description of the examination in the text of the article —L. Harden

The testing of these three patterns, each repeated ten times, makes up the first part of the examination Summarizing, we have (*a*) the lifting of the hand—a visual pattern, (*b*) the spoken sound "ai" —a sound pattern, and (*c*) the tap of the foot—a combination of a visual and a sound pattern. The tap of the pencil precedes each of these patterns.

If the child responded even once with the pattern movement or the spoken "ai" without the reaction of the experimenter, i.e., if his response followed the tap of the pencil only, it means *that the associated reflex was exhibited* When the examination has been completed the number of such responses is entered in red on the record sheet and is rated as *associated excitement*

If the child gave no response either to the tap or to the pattern, this fact is entered in blue on the sheet and is rated as *inhibition*

The first part of the examination, then, furnishes data on the following points: (*a*) whether or not the associated reflex was exhibited, (*b*) if exhibited, was it extinguished, i.e., did it later fail to appear; if so, how soon did such extinction occur, i e, how many times was the pattern exhibited in response to the tap only; (*c*) whether or not the response was given to all the pattern, (*d*) whether or not the response corresponded to the pattern given or to the previous pattern. Responses to the previous pattern did occur, and, we believe, should be considered as "traces"; in scoring we counted them as *associated excitement* and indicated them in red on the record sheet.

The second part of the experiment follows immediately after the first, with no fixed rest period. An idea of the general plan of this part of the examination may be gained by reference to Part II of the record sheet as reproduced in Figure 2.

The same time relationships are observed as in Part I, i.e., the unequal intervals intervene between trials as shown in the first column of figures in Part I of the record sheet The two-second interval between the tap of the pencil and the giving of the combined pattern by the examiner is also maintained in order that the associated reflex may be given a chance to show itself.

In the first section of Part II (Figure 2, Part II, *a*) all three patterns are given simultaneously, thus they are *integrated in time* Four trials or associations are given and the following items noted on the record sheet: (*a*) did the child exhibit all three patterns as did the experimenter, (*b*) if not, how many patterns did he miss, and (*c*) did the child give the response after the pattern was given

by the examiner or did he give it after the tap only The absence of some of the patterns is rated as *insufficient integration* and scored in blue As in Part I of the examination, if the child made movements after the tap of the pencil but before the pattern was given, those movements having been acquired in the earlier part of the examination, it was rated as a phenomenon of the "trace" type and was scored in red as *associated excitement.*

The examiner then eliminates one of the three patterns (Figure 2, Part II, *b*) and notes whether or not the child does the same. If he responds distinctly with only those of the patterns which are given by the examiner, it means that the child *inhibits differentially* (selective inhibition) If he does not give the same patterns as are given by the experimenter, it means that his inhibition is not correct, his *differentiation is not sufficient.* In such a case the superfluous patterns are scored in red, the missing ones in blue.

Next the combination of the three patterns is reinforced by two repetitions (Figure 2, Part II, *c*). Following this, the examiner omits the second pattern (Figure 2, Part II, *d*), and then, in the same way, after another two-repetition reinforcement of the combined pattern (Figure 2, Part II, *e*), he omits the third pattern (Figure 2, Part II, *f*). Finally, two patterns out of the three are omitted (Figure 2, Part II, *g*) This completes the examination The results, when entered, supply data on the following points. (*a*) the formation and extinction of the associated reflex; (*b*) exclusion, an inhibitive process, (*c*) differentiation (selective inhibition); and (*d*) integration (selective integration)

The following question may be asked: Why are the patterns in the first part of the experiment given just ten times, no more and no less? It was determined empirically that, under the conditions of the examination, in most children of school age the associated reflex was established in the course of ten repeated associations of the tap of the pencil with the pattern But, even if the associated reflex does not show itself overtly during the first part of the examination, that does not mean that it was not formed at all—it may show itself during the second part of the examination. This is the phenomenon of which we have spoken before, the so-called "trace" It may also be called "inhibition from the very beginning," in fact, it is so considered in the Bekhterev Institute.

Associated activity is the natural and indispensable function of

the nervous system, but the overt manifestation of the reflex is by no means necessary. The regulation of its manifestation is cared for by the process of differentiative inhibition Thus the formation and breaking of the associations[4] must be considered as processes of excitement and inhibition and are shown quite adequately by our experimental method

In fact, this simple examination, which requires no special apparatus and very little time (12 minutes), makes possible the collection of data on the quality of the function of the nervous system and all its essential characteristics. It has been used for several years by the Leningrad Institute,[5] and the data collected have made it possible to compare the ratings of different groups of children, viz, pupils of the schools for pedagogically untrained children, pupils of the factory schools, pupils of schools for the feebleminded, etc

We have at present over 6000 results of individual investigations, on the basis of which it would be possible to determine sex and age norms, as well as the characteristics of the different groups. Correlations between the scores on this examination and ratings on social conditions, the general state of the organism, success in school work, etc., might also be determined.

In order to put the data of the reflexological examination in a precise and understandable form and to determine in how far the function of the central nervous system of a given child compares with that of others of his age and sex, norms were worked out based on the results of the investigation carried out in one of the Leningrad normal schools (School No. 199) One thousand pupils of both sexes, from 8 to 19 years of age, were examined.

Two points should be noted in regard to the subjects of this investigation (*a*) All pupils of the school were tested, hence there was no special selection. (*b*) However, it must be borne in mind that a natural selection necessarily operated in the higher grades, since the children attending those grades are naturally the most successful students. This fact may have an influence on the individual components of some profiles which show a markedly high level in subjects between 14 and 15 years of age

From the data obtained on these one thousand pupils sigma distributions were made for each sex and each age from 8 to 19 years in

[4]In a simple or more complicated aspect
[5]During every year from 2000 to 2500 children are examined

the same manner as had been done for the anthropometric measures The anthropometric profile presents the characteristics of the physical development of a child in relation to the average child of his age and sex, while the reflexological profile shows the developmental level of the various mechanisms of the nervous system of each child in relation to the average, or, in the case of group profiles, the average rating of the group on each of the components as compared with the standing of the normative group.

The stability of the type of function measured is shown by our repeated examinations, the changes occurring only with age. It was shown that 81% of the records of the second investigations showed the same character of function as did the first investigation, and only 19% of the cases showed a rather distinct deviation from the previous profiles In most of these cases of distinct deviation the presence of some biological factor could be shown to have been a disturbing element at the time of either the first or the second testing; in some cases disturbing social factors seem to have played a part.

In the actual preparation of the profiles a card covering 17 points (presented as Figure 3), data on each of which are obtained from the record sheet, is used. Each point represents a component of the total function of the nervous system.

We shall now take up each of these components in turn. Figures

Associated											Differentiation			Integration		Group
Excitement							Inhibition									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Response without stimulus	Occurrence of the associated reflex	Association at which the associated reflex appears	Number of associated reflexes	Number of traces	Number of superfluous responses when excluding one pattern	Number of superfluous responses when excluding two patterns	Number of failures to give response movements	Number of responses of one pattern to two	Number of responses of two patterns to three	Number of responses of one pattern to three	Number of correct differentiations	Inertia	Number of responses of other movements	Differentiative integration	Trace-integration (false)	Groups

FIGURE 3

General Plan of the Profile Card, Listing the 17 Components and Showing Their General Classification

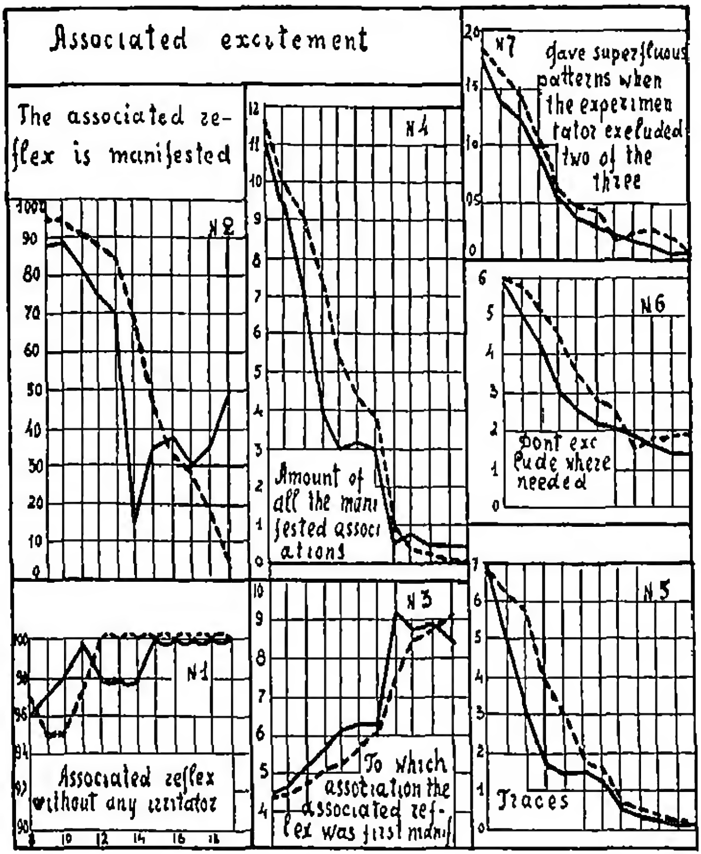

FIGURE 4

AGE CURVES FOR COMPONENTS 1-7, i e, THOSE RATED AS SHOWING ASSOCIATED EXCITEMENT

Editorial note Figures 4, 5, 6, 9, 10, and 11 have been used as submitted by the author. In referring to Figures 4, 5, and 6, note that the numbering of the various sections, i.e., the curves for the successive components, runs from bottom to top Note also that the measures (ages in years) indicated along the abscissa, as given at the bottom of the first column of Figure 4 and at the bottom of each column of Figure 5, apply to all sections of these three figures The figures on the ordinates indicate average numbers of occurrences of the various responses, except in the cases of Components 1, 2, 15, and 16, where the figures are in percentages, and in the case of Component 17, where it is not clear to what they refer —L Harden

4, 5, and 6 present the age curves for each of the components separately The solid lines represent the curves for the boys, the dotted lines, those for the girls.

First component. Response without stimulus. The examiner scores on the record sheet the reproduction of any pattern which occurs without the tap of the pencil and the examiner's pattern. The age curve of this component increases progressively up to the eleventh year, remaining after this age at the level of 100% (total dropping out of such responses), which means that *the greater the age the less frequent the exhibition of this component* The presence of this factor is scored with a plus sign on the card, while its absence is scored with a minus sign The rating here is what might be termed of an "alternative character" This component is scored in the first as well as in the second part of the examination

Second component. Occurrence of the associated reflex. Here again the score is an alternative one, the experimenter records whether or not the associated reflex was exhibited during the first part of the test. The curve decreases with age which means that *the greater the age the less frequently is the associated reflex manifested.* In scoring this component the experimenter uses a plus sign to designate the presence of the reflex and a minus sign to denote that it did not appear

Third component: Association at which the associated reflex appears. The examiner enters on the profile card the number of the association (trial or repetition) at which the associated reflex made its first appearance, i e., he takes the trial number of the first red minus sign on the left of the record card If in the ten trials with the first pattern the associated response did not appear at all, the score is counted from the number of trials from the beginning of the pattern in response to which the reflex was first shown In case the reflex does not appear at all the score is given on the card as $10 + x$, which simply means that it is recognized that the associated response might have been established if more than ten trials were given. The curve for this component rises with age, i e, *the greater the age the more the associations needed in order to establish the associated response.*

Fourth component: Number of associated reflexes In scoring the fourth component the examiner counts the actual number of overt responses, i e., all the red minus signs on the record sheet for the

first part of the examination The curve for this factor falls with increase in age, i.e., *the greater the age the smaller the number of reflexes displayed*

Fifth component Number of traces The score for this component is derived from the records of the second part of the examination, i e, during the testing of the integration and differentiation processes, and is determined by the frequency of appearance of responses to the tap of the pencil alone, i e., prior to the examiner's giving the pattern The curve falls with age, i e, *the greater the age the fewer the traces.*

Sixth component Number of superfluous responses when excluding one pattern. (From the second part of the examination) This component is represented by that type of response in which the child responds with superfluous patterns when the examiner excludes one or two patterns. Those responses (occurring at the very end of the examination) in which the child gives two or three patterns when the experimenter gives only one are also of this general type, but we have considered them separately as the seventh component. The score for the sixth component, then, is the number of superfluous responses when the examiner has eliminated one pattern The curve falls with age, i e, *the greater the age the less frequently are the superfluous patterns exhibited*

Seventh component Number of superfluous responses when excluding two patterns The score for this component is determined by the number of superfluous responses occurring at the very end of the examination when the examiner has eliminated all but one pattern Like that for the sixth component, the curve falls with age, i e, *the older the subjects the fewer the superfluous patterns exhibited when the examiner has eliminated two of them.*

Since the seven components which we have considered thus far may all be attributed to the phenomenon of associated excitement, we have united them under that title on the cards

Eighth component: Number of failures to give response movements. This score comes from the first part of the examination and consists of the number of trials or associations in which the child did not respond to the examiner's pattern. On the record sheet this is scored in blue with a minus sign just to the right of the printed figures The curve decreases with age, i e., *the older the subjects the less frequently do we find this lack of response, or inhibition*

Ninth component: Number of responses of one pattern to two. (From the second part of the examination.) The score is determined by the number of times the child gives only one pattern when the examiner gives two patterns, i.e., excludes one of the three. The curve shows that *the greater the age the less frequently does this deficiency of response occur.*

Tenth component: Number of responses of two patterns to three. (From the second part of the examination.) As with the ninth component, the score is the number of incomplete responses,

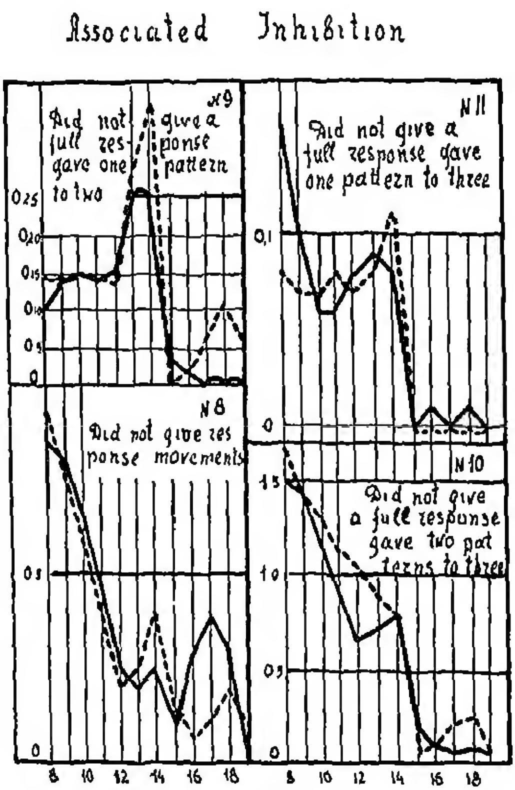

FIGURE 5
Age Curves for Components 8-11, i.e., Those Rated as Showing Associated Inhibition

and the curve shows that *the greater the age the less frequently does the incomplete response occur.*

Eleventh component: Number of responses of one pattern to three. (From the second part of the examination.) In this case, when the examiner combines the three patterns, the child responds to only one of them. The response is scored as occurring once, more than once, or not at all. *The curve falls with the increasing age of the subjects,* and after 15 years occurs only in rare cases

Components 8, 9, 10, and 11 are combined under the title of "associated inhibition." Only superfluous inhibition is scored under these components, since the insufficiency of inhibition is scored as the process of associated excitement under Components 1-7.

Twelfth component: Number of correct differentiations (From the second part of the examination.) The examiner here determines the number of correct responses, i e, the number of trials in which, during the excluding of one or two patterns, the child responded with the same pattern or patterns that were given by the experimenter. The curve is found to rise with increasing age of the subjects, i.e., *the greater the age the greater is the number of correct differentiations*

Thirteenth component: Inertia (From the first part of the examination) The score for this component consists of the number of the responses in which the child gives the previous pattern when the pattern for the present response has not yet been given by the examiner or when the next pattern has been given

Fourteenth component Number of responses of other movements (From the second part of the examination.) Under this component are counted responses which include movements other than those given by the examiner when he eliminates one or two patterns. The number of false responses constitutes the score

Components 12, 13, and 14 are grouped together under the title of "differentiation," since the presence of differentiation is determined by the scores on these components

Fifteenth component Differentiative integration. (From the second part of the examination.) The examiner records whether or not all the complicated patterns are fully reproduced by the child, i e, whether or not the child integrates selectively. If he does, the response is scored plus; if even one pattern has not been fully reproduced, the response is scored minus. The appearance

of differentiation (Component 12) is also noted, for it may be supposed that the patterns are given in full not because of selective integration but because of associative excitement (traces). In this case the patterns are exhibited in response to the tap only, before the examiner has time to exhibit them

Sixteenth component: Trace-integration (false). The following

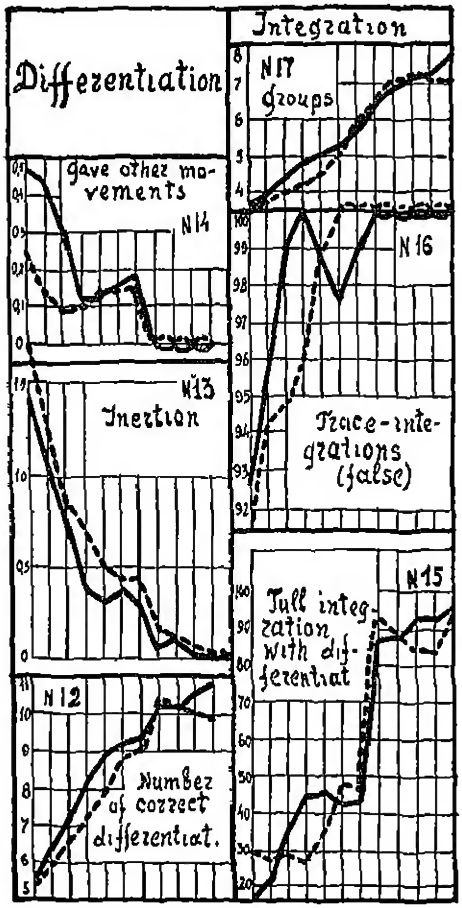

FIGURE 6

AGE CURVES FOR COMPONENTS 12-17, I E, THOSE RATED AS SHOWING DIFFERENTIATION, INTEGRATION, AND GENERAL QUALITY

cases are scored under this head. (*a*) those in which all patterns are given in full; (*b*) those which are given because of association, i.e., immediately after the tap, before the examiner's pattern, and (*c*) those which show a lack of differentiation when one or two patterns are excluded The presence of each of the three phenomena is scored minus, their absence is scored plus.

Seventeenth component "Quality" group. From the rating table (reproduced as Figure 7), the "quality" group to which the function of the nervous system of a given child must be assigned is determined, and the corresponding level noted on the profile card

We may now consider briefly the drawing and interpretation of the profile. The profile card (see Figure 8) is arranged according to the following general principle: If the curve for a given profile rises with increasing age, the data are ranged from bottom to top; if the curve falls with increasing age, the data are ranged from top to bottom, i.e., in inverse order. Thus, the best ranking is

No associated reflex No traces	Full integration	00
No associated reflex No traces	Incomplete integration	0
Stable associated reflex No traces	Incomplete integration Full integration	1-a 1-b
No associated reflex Traces	Incomplete integration Full integration	2-a 2-b
Unstable associated reflex Traces	Incomplete integration Full integration	3-a 3-b
Stable associated reflex Traces Differentiation	Incomplete integration Full integration	4-a 4-b
Associated reflex nearly always manifested No differentiation	False integration	5

FIGURE 7
"QUALITY"-GROUP RATING TABLE

always at the top, the poorest at the bottom. As shown in the figure, the mean of the group (M) is marked off with a heavy line, while each line above or below represents plus and minus sigma deviations from that mean. The individual scores (from the original record sheets) on each of the 17 components are converted into sigma scores and the appropriate standing indicated on each of the 17 vertical lines of the profile card The profile is then completed by drawing the connecting lines.

For each individual the average of all the sigma standings is then computed and indicated as H (height). An H falling between $\pm$ 5 is considered normal, while an H higher than $+.5$ is rated as supernormal (see curve No 1, Figure 9, where H $= +$ 6) A profile which shows marked deviation (2 σ or more) both above and below M is rated as abnormal and is considered to indicate *dis-*

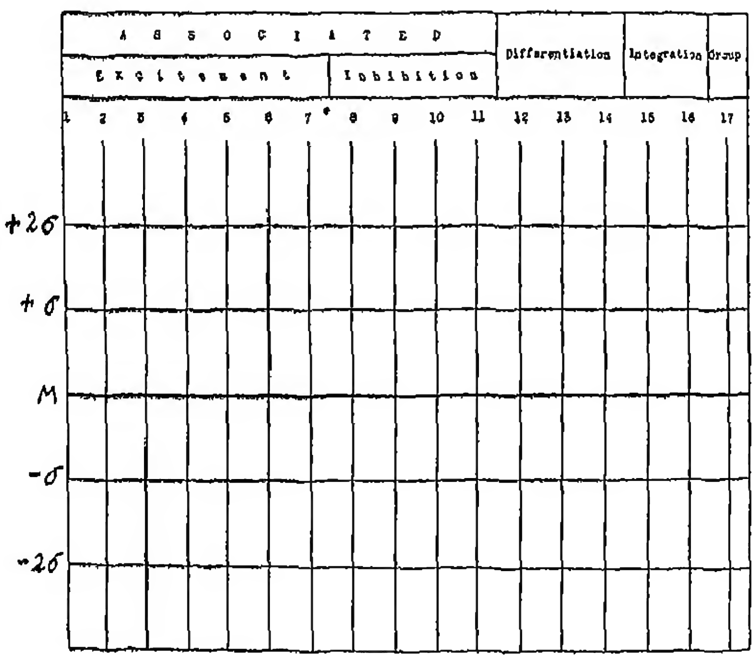

FIGURE 8
PROFILE CARD

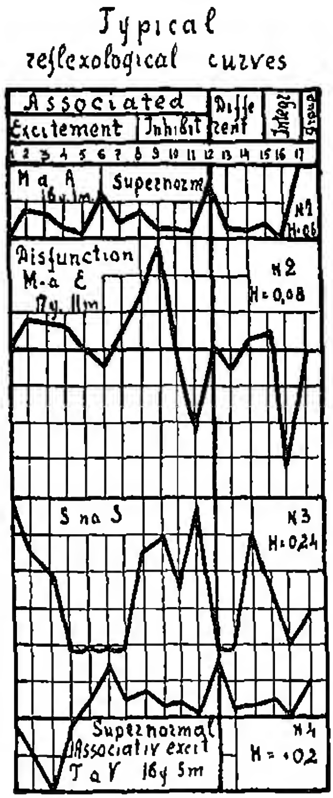

FIGURE 9
TYPICAL REFLEXOLOGICAL CURVES (PROFILES)

function of the central nervous system (see curve No. 2, Figure 9). If H is lower than .5 the individual is rated as having subnormal functioning (see curve No. 3, Figure 9, where H = —2.4).* A profile may also reveal peculiarities or specific disabilities of an individual. For instance, Curve No. 4, Figure 9, shows supernormal rating except for an exaggerated associated excitement.

Group profiles may also be drawn. Figure 10 presents such a profile for 14-year-old boys and girls (separately) of a pedagogically

*Editorial note. The figure given on curve No. 3, Figure 9, is 0.24, which is obviously incorrect.—L. Harden

untrained group In preparing the group profile the record sheets are first classified according to sex and age, and the average rating on each component is then calculated for each sex-age group, and the profile drawn as for an individual; the profiles for both sexes may be entered on the same card as shown in Figure 10.

In Figure 11 we illustrate another method of organizing the data with which we have been dealing which shows very clearly the proportions of normal, supernormal, and subnormal cases in any given group

SUMMARY

In this paper a brief description is given of the reflexological examination which is used at the Leningrad Institute for Child and Youth Health Care as a part of a more general examination. The purpose of the particular examination is to determine age and sex characteristics of the functioning of the central nervous system as revealed by the associated-reflex technique.

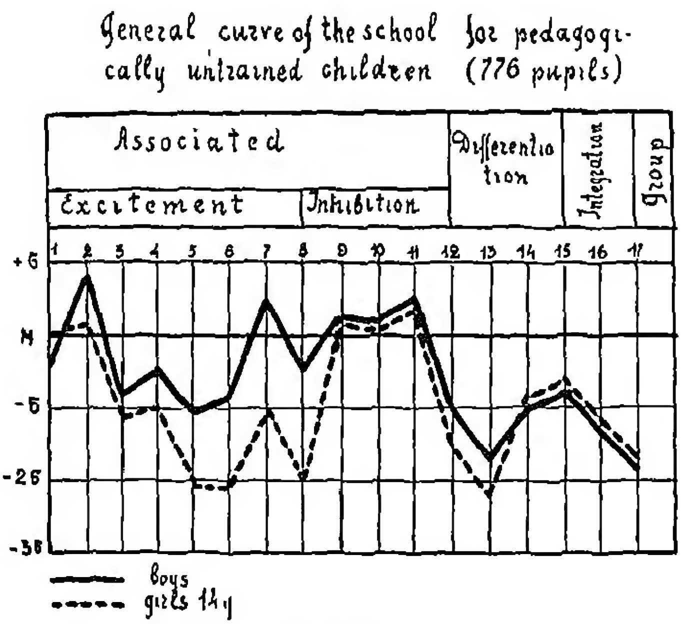

FIGURE 10
GROUP CURVE (PROFILE) FOR A SCHOOL OF PEDAGOGICALLY UNTRAINED CHILDREN (776 PUPILS)

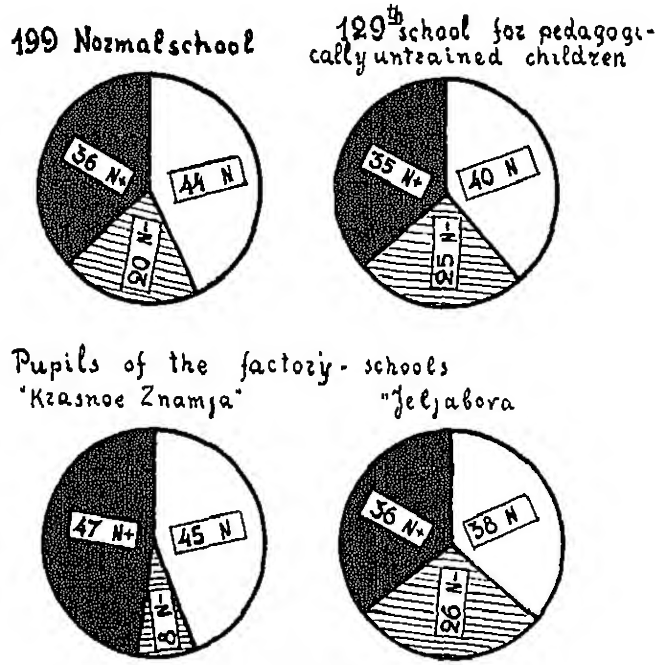

FIGURE 11

DIAGRAMS SHOWING PERCENTAGE DISTRIBUTION OF NORMAL, SUBNORMAL, AND SUPERNORMAL INDIVIDUALS IN VARIOUS SCHOOLS

From experimentation with the establishment of three very simple associations, and combinations of these, scores are obtained on 17 components (grouped under the following categories· associated excitement, associated inhibition, differentiation, and integration), which reveal all the essential characteristics of such functioning

Age curves for each component (for each sex) are presented for a group of one thousand 8- to 19-year-old pupils of a Leningrad school.

The construction of profiles is described, and a few individual profiles presented to illustrate the various levels of functioning The group profile is also illustrated

The Leningrad Institute for Child and Youth Health Care
Leningrad, U S. S R

LES PRINCIPES FONDAMENTAUX D'UNE MÉTHODE POUR ÉTUDIER LA FONCTION DU SYSTÈME NERVEUX COMME MONTRÉE PAR LE COMPORTEMENT OUVERT

(Résumé)

Dans cet article on donne une courte description de l'examen réflexologique dont l'on se sert à l'Institut de Léningrad pour la Santé des Enfants et des Adolescents comme partie d'un examen plus général Le but de cet examen spécial et de determiner les caractéristiques d'âge et de sexe du fonctionnement du système nerveux central comme montrées par la technique du réflexe associé

De l'expérimentation avec l'établissement de trois associations très simples, et des combinaisons de celles-ci, on obtient des résultats sur 17 composantes (groupées sous les catégories suivantes. agitation associée, inhibition associée, différentiation, et intégration), lesquelles montrent toutes les caractéristiques essentielles de ce fonctionnement.

On présente des courbes d'âge pour chaque composante (pour chaque sexe) pour un groupe de mille élèves d'une école de Léningrad, âgés de 8 à 19 ans.

On décrit la construction des profils, et on présente quelques profils individuels pour illustrer les divers niveaux du fonctionnement. On présente aussi le profil collectif.

DERNOWA-YARMOLENKO

GRUNDLAGEN EINER METHODE ZUR UNTERSUCHUNG DER TATIGKEIT DES NERVENSYSTEMS IN IHRER OFFENBARUNG IN DER AÜSSERLICHEN TATIGKEIT

(Referat)

Es wird in dieser Abhandlung die im Leningrader Institut fur Gesundheitspflege der Jugend als Teil einer mehr allgemienen Untersuchung verwendete reflexologische Untersuchung kurz beschrieben Absicht dieser besonderen Untersuchung ist die Bestimmung der fur jedes Geschlecht und verschiedene Alter karakteristischen Merkmale der Funktionierung des zentralen Nervensystems in ihrer Offenbarung durch das assoziierte-Reflexverfahren (associated-reflex technique)

Aus der Experimentierung mit der Bildung dreier sehr einfacher Assoziationen und Verbindungen dieser Assoziationen werden an 17 Bestandteilen der Untersuchungen (in folgende Gruppen klassiert assoziierte Erregung, assoziierte Hemmung, Differenzierung, und Integrierung), welche alle wesentliche Eigenschaften solcher Funktionierung offenbaren, Zahlen berechnet.

Es werden fur jeden Bestandteil (fur jedes Geschlecht) Alterskurven gegeben, die an einer Gruppe bestehend aus 1000 acht-bis-neunzehn-Jahralten Schuler einer Leningrader Schule erhalten worden sind.

Es wird die Konstruirung der Profile beschrieben, und es werden zur Illustrierung der verschiedenen Niveaux der Funktionierung einige individuelle Profile dargestellt Das Gruppenprofil ist ebenfalls illustriert

DERNOWA-YARMOLENKO

A METHOD FOR MEASURING THE SUSTAINED ATTENTION OF PRESCHOOL CHILDREN*

From the Department of Psychology of Northwestern University

HELEN S. SHACTER

That there exists a state of indecision and uncertainty as to just what one may expect of preschool children in the matter of attention is evident to anyone having any direct contact with them or having acquaintance with the literature concerning the numerous manifestations of attention The picture of the small child flitting from one activity to another with what seems to be extreme rapidity is by no means uncommon, but whether to insist upon longer application to one activity, or to provide sufficiently diverse activities to meet the continuous shifting of attention, whether to be concerned over the one, or to accept the other, of necessity remains a matter of conjecture, since scant experimental data are available upon which to base adequate procedure The development of sustained attention during the preschool years remains an almost unexplored field of research, although the existence of many problems involving attention are well known.

Granted, then, the child's attention is volatile; it can be attracted, but can it be held, and if so, for how long? What factors are involved, not in gaining the attention of the child, but in retaining it? Are there age differences noticeable in sustained attention in the preschool years? Can we say when we may legitimately expect the normal child to be ready for prolonged periods of sustained attention? Is there a sex differentiation in the sustaining of attention?

These questions are all problems which arise daily in situations where young children are involved Little investigation has been attempted in this field, the lack of complete data is probably due in part to the difficulty of measuring the attention process The vast body of literature on attention does not include much factual evidence on the previously mentioned questions, and there is unquestionably

*Recommended by John J B Morgan, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, December 15, 1932.

a practical need for further accurate and scientific information concerning the process of attention as it is evidenced in young children

Tilson's study (47) in 1929 is a striking illustration of the frequency of the occurrence of difficulties of adjustment due to inattention. A survey was made of seven child guidance and habit clinics, located in five different cities, and the types of problems which were referred during a period of a few months were listed In an age range from one to five years, there were 53 types of problems, including physical, social, and emotional difficulties, the ninth in order of frequency was "restlessness," the term being used and carefully explained to designate problems of instability of attention.

An appreciation of the importance of attention in the development of children is indicated in Burnham's (4) treatment of the topic when he states

> " . The development of habits of attention . , is quite as important for the prevention, as reeducation for the cure, of nervous and mental defects" (p 528)

Titchener (17) pointed out the importance of the subject of attention in his statement that

> ". . . the intrinsic tendency of psychology to deal with attention in the large has been further strengthened by the practical importance of attention, its importance in educational regard . . Here, if anywhere, a sound psychology (of attention) might be of immediate service to the responsive teacher" (p. 182).

Since there is little beyond conjecture in this field, and since the problem exists not only as one of interest to the scientific investigator, as an incompletely known phase in the developmental process of young children, but also as one of practical significance for the educator, as a basis for pedagogical and social procedure both in and out of school, no further explanation is necessary for the initiation of the study which the writer will report.

The study embodies an experimental procedure which was formulated to give a readily scorable measure of the attention-span of the young child. Utilizing materials and activities attractive to preschool children, six situations were organized wherein periods of sustained attention could be scored in intervals of minutes and seconds. The time element was the chief interest in relation to the

sustaining of attention in young children, the developmental aspect was the chief object of the investigation

The Literature

The literature describing "attention" is enormous, and the definitions offered by the many commentators are legion For example, we may describe attention as a feeling or emotion, or we may consider it as a state of muscular adaptation; we may, rather, treat it as a change in the clearness of ideas. Justification can be found for the multitude of approaches to the subject of attention in the fact that there are so many different angles upon which the chief emphasis may be placed in considering it. Whatever our bias, we may cite numerous authorities to uphold and to strengthen our point of view. Attention is a very equivocal and generic term

Titchener (17), in 1908, attributed to the growth of experimental method in psychology the discovery of attention as a problem of that body of knowledge. He wrote:

> " what I mean by the 'discovery' of attention is the explicit formulation of the problem, the recognition of its separate status and fundamental importance, the realization that the doctrine of attention is the nerve of the whole psychological system . The discovery . was something like the discovery of a hornet's nest, the first touch brought out a whole swarm of insistent problems" (p 173).

And not only has there been no general acceptance of any precise definition of attention, but its measurement has continued a matter of contention throughout the years since its "discovery."

The range of theories is extensive, nor does the passing of time and the steadily increasing number of investigations seem to elicit greater agreement among contemporary psychologists than that which existed during the last quarter of the nineteenth century It would seem that we might well agree with Ebbinghaus (8) that "Die Aufmerksamkeit ist eine rechte Verlegenheit der Psychologie" (p 611) and conclude that the plaint of Pillsbury (14) concerning the chaotic condition of attention is almost as true now as it was when he wrote. And even while we wonder what made James (11) suggest that 'Everyone knows what attention is" (p 403) we recall that Boring (2) maintains that

> ". . . Of course, selection, attention, or determination (and there are many other terms for the same thing) has remained a persistent problem in psychology" (p 87)

But it may be noted that Pillsbury (15) wrote "the terms used to describe the fact are less important than the fact" (p 137). To hear the testimony of a multitude of psychologists still leaves one free to select any, or part, of the variety of descriptions offered

Experimental studies of attention have been as varied as the theories offered as to just what attention is. According to Baldwin (1), the investigations may be grouped under eight different classifications. A more compact division was suggested by Pillsbury (14), who placed the measures of attention into three groups, in the first he included measures of accomplishment in some set task, the second involved fluctuations of attention, and the third measured the amount of stimulus necessary for distraction

The earlier investigations, which date back to the work of Wundt (20) and of Obersteiner (13), in 1874, are reviewed in a survey by Geissler (9), which appeared in 1909, later experimentation is noted in considerable detail by Dallenbach (5, 6, 7) bringing a résumé of work on attention up to 1928 A thorough treatment of the European experimental work on attention is given by Henning (10) in a volume published in 1925. To these the reader who desires a descriptive historical account of the investigations of the attention process is referred.

Indication of changing attitudes toward the attention problem may be observed from a consideration of the literature of the past decade, this is reflected chiefly in the increasingly accepted concept that the attentive consciousness is an integrated whole If one proceeds on the assumption that attention is sensory clearness, an experiment may be completed to prove introspection the only measure of attention; if one assumes that attention is an equivalent to preparedness of the nervous system to react to a stimulus, reaction-time is held the proper measure of attention thus defined But if one proceeds to investigate certain phenomena, and not demonstrate any particular theory, one may simply accept the fact of attention and quite properly consider its overt characteristics

Few experimental investigations have been conducted which contribute to our knowledge in regard to the attention process in young children While, as has been noted, the body of psychological lit-

erature yields almost countless experiments and reports on the subject of attention, wherein are offered a variety of definitions and numerous conflicting opinions as to what is meant by attention, on what it depends, and how it may be measured, a fundamental acquaintance with these factors in relation to the early years of childhood remains to be made

We have an increasingly large number of studies of child development, but until some five years ago these omitted mention of the subject of attention. Not even such investigations as that made during a six-year period at the Yale Psycho-Clinic under the direction of Gesell (36), the results of which were published in 1925, or that undertaken from 1924-1927 in the Preschool Laboratories of the Iowa Child Welfare Research Station under Baldwin and Stecher (27), and published in the latter year, touch upon the sustained attention of the subjects of the investigations mentioned, or upon the great variety of interests of these children, or make any comments on any findings as to the factor of attention-span as related to the child's development. In a later approach of Gesell's (37) there did appear some mention of the attention process, but no suggestion of quantitative measurement is presented, and behavior aspects are indicated qualitatively only through the thirty-month level.

The *Twenty-Eighth Yearbook of the National Society for the Study of Education* (44), published in 1929, was devoted to preschool and parental education A "Survey of Recent Research in Intellectual Development" was presented, which included titles of 37 different studies of early childhood. Little evidence may be gleaned from these sources as to the subject of attention, indeed, few make any mention of it There were also listed the research projects in progress at the time of compilation in the various centers for child study and research throughout the country There was included no instance of any current investigation of the subject of attention

While the general impression from a survey of the literature on child psychology is indisputably one of neglect of the attention process, there are reported several observations of play activities of young children, some of which make pertinent notes on the factor of attention, under conditions varyingly controlled Mention may be made of the studies of Bridges (30, 31), wherein the duration

of the occupational interests of three- and of four-year-old children was noted, and of reported observations of Bott (29) concerning the attention-span of two-, three-, and four-year-old children when engaged with play materials in a group. These were published in 1927 and in 1928, respectively. The following year appeared a monograph by Cushing (32) concerning a perseverative tendency in preschool children, and in 1930 there was published a study by Herring and Koch (39) concerning the interest span of two- and four-year-old subjects In 1931 Moore (42) published ratings for what was designated as the sustained attention of young children, but what was actually considered were "certain manifestations of the effort with which the child will work toward a goal," denoted as perseverance. In the same year Nelson (45) attempted to evaluate the spontaneous activity of three-year-old children incidental to psychological test situations, and presented data regarding the persistence of the subjects observed, which was measured by the time spent at a formboard test without obtaining a successful solution. In 1932 Van Alstyne (48) observed groups of children in nursery-school situations, but, while "attention-span" was said to be recorded, the record was of group play sustained rather than of attention sustained.

Investigations dealing directly with some aspect of the attention process of young children have been made in only four reported instances That it is a ripe field for research was indicated almost two decades ago by Woodrow (18), who remarked on the lack of such studies.

> " . It would seem natural to expect that the degree of attention would increase with age Careful observation indicates in many ways that an adult is capable of attending to a given task much better than a child This seems so obvious that it may even be regarded as a test of the validity of any method of measuring attention that its application result in higher values of attention in the case of adults than in the case of children. I am unable at present to present data on the growth of attention To do this it is necessary to measure the attention of a number of children of each age, or else to measure the same children year after year from an early age up to maturity" (p 143)

The first published account of a study of attention using preschool-age subjects is that of Bertrand (21) in 1925. This simulates the

observational material already described, in that children, ranging in age from two to six years, were allowed to choose any of a number of educational games displayed on the schoolroom table and to play with it as long as they chose. The 36 subjects were each seen 18 times, with the exception of 3, in whose cases illness prevented a completed period. Bertrand presented results showing that the time spent with a chosen toy increased with the age of the subject, that the means for the girls were slightly higher than those for the boys, and that the individual children varied in their attention-spans on different days. The group as a whole, divided into three different age groups, gave a picture of longer periods of sustained attention with increasing age: the three-year-old children averaged 10 minutes, the four-year-olds averaged 16 minutes, and the five-year-old group averaged 25 minutes. The groups were composed respectively of 7, 8, and 21 children. The uneven distribution of cases, with the oldest group so much larger than the other two, may have operated to present the marked increase in the third age span; the two younger groups consisted of too few cases from which to draw conclusive evidence.

Another French investigator considered the causes of inattention in young children. Wallon (24), in 1929, avoided the term "attention" as ambiguous; he considered "inattention" a generic term designating the different forms of activity into which the act of attention can be analyzed and which constitute the concrete and positive experiences of the educator. His conclusion was that motor disorders are correlated with most of the causes leading to inattention.

More nearly approximating an actual experimental situation, Brown (22), in 1930, completed what is probably the first laboratory approach to the study of attention in preschool children. Sixteen five-year-old children were tested over a period of two consecutive school weeks. On each of the 10 days of the study, a continuous reaction experiment was conducted, using apparatus which required the subject to react to the flashing of four different lights by a specific movement for each light. The four lights were presented as the eyes of a pair of twin cats; the specific movement was to press a particular telegraph key for each eye. A kymograph record of the subjects' responses was made. All of the subjects were given the Stanford Revision of the Binet test as a means of measuring their intelligence.

Proceeding upon the assumption that "a measure of efficiency in performing a simple motor act is also a measure of attention," the experimenter aimed to deal with the measurement of attention by noting the acquisition of its control It was found that

> "(1) All children tested improved in their ability to perform the task required
> "(2) This improvement was closely accompanied by reduction in variability of performance.
> "(3) Both variability and level of final achievement appear to be functions of the ability to distribute attention over a field, an ability which is, in itself, a point of individual difference and subject to modification
> "(4) A condition of emotional stability appears to be essential for successful response in all situations requiring concentration of attention" (p. 287).

Throughout the experiment there were striking individual differences in the behavior of the children which seemed to the investigator to be due to fundamental differences in personality development In adjusting to the novel situation which the experiment presented, intelligence was said to be much less involved than previous training in cooperation and self-control.

One other study of attention as manifested in preschool children has been published Leontiev (23), in 1932, arranged a test situation for voluntary attention which was presented to 7 preschool children, aged five, 15 school-age children, aged eight to thirteen, and 18 adults, aged twenty-two to twenty-seven. The experiment involved asking a number of questions to which a one-word response was required, with certain words forbidden as responses Some of the questions necessitated answering with the name of a color. Cards bearing various colors were given the subject before the questioning commenced, with the remark that they were to help him reply, and he was told that two color-names were not to be included in his responses, these two colors were on the card, together with several colors permitted in mention. Leontiev assumed that

> ". . The development of voluntary attention means, first of all, that the child acquires a series of habits of behavior" (p 63)

He apparently felt that such acquisition takes place later than preschool age; his conclusions were·

" . The child's attention, which at first is involuntary, i.e., depends directly on the action of stimuli, is transformed in the process of its development into the voluntary attention characteristic of an adult. This process of transformation takes place on the basis of the control of the child's attention from without, with the help of external stimuli. The child, feeling the effect of these external stimuli on himself, and learning in his turn to react on others around him, becomes capable of using external stimuli with the idea of organizing his own behavior By thus controlling stimulation, the child controls his own attention . Children of preschool age prove incapable of actively using external auxiliary stimuli as means of organizing their own behavior In early school years, however, the child learns to organize his behavior from without, with the help of external stimuli" (pp. 79-80)

The writer is not wholly in accord either with the hypothesis upon which Leontiev based his investigation of voluntary attention or with the experiment itself as a measure of it.

Habits of behavior are acquired in early infancy, at a developmental period when there has been no progress apparent toward the acquisition of habits of voluntary attention. The extreme motility of the attention of very young children does not prevent the formation of certain habits built upon the rigid sleeping, eating, and dressing procedures which constitute the small child's daily regular routine The writer cannot, therefore, accept the assumption of Leontiev, that "the development of voluntary attention means . that the child acquires a series of habits of behavior."

The experiment devised by Leontiev to gauge the development of voluntary attention seems to the writer to involve other influential and variable factors upon which success in the experiment is conditioned. The directions are too lengthy to offer a simple presentation to the child of what he is expected to do, the obvious result would be a confusion as to just how to respond How may one judge whether the voluntary attention of the subject to the situation is being measured, or whether his comprehension of directions, and his ability to carry out such directions, are not the prime factors to be considered as regulating the responses made?

Furthermore, all observational studies of the play activities of young children point to certain conclusions concerning materials of great and of little appeal to them, most of which have not been

considered in the Russian investigation The writer refers to the manipulative tendencies of young children, to their responsiveness to experiences involving concrete objects, to their distractibility in purely verbal situations, and like findings of recent investigators, already mentioned The fact that Leontiev's seven subjects were placed in a situation where each was the avowed object of observation, where the attention of the examiner was concentrated upon him, rather than in one where each subject was the performer, and hence not exposed to the inevitable subjective angle so emphasized by the question-answer situation devised, must be taken into consideration when noting the results presented

These investigations, then, constitute the whole printed evidence concerning attention as it is manifested in young children, leaving, obviously, much to be learned

The Experiment

To insure clarity, it may be wise to restate at this point the specific problem of the present study The purpose was to develop an experimental approach for studying the attention-span of preschool children, with particular emphasis upon ascertaining the following data (1) when one may reasonably expect the young child to cease flitting from one activity to another and give normal evidence of sustained attention; (2) if there is a developmental level when there should be readiness for prolonged periods of attention to a single activity—as, for example, there is now a recognized period for beginning reading, (3) if it is possible to assign an attention-span to each successive preschool year-level—as Bott (29) did in noting the attention-span of her preschool subjects to be of a duration (in minutes) equal to the sum of their chronological ages (in years) plus one; (4) if the complexity of the activity engaged in influences the time of sustained attention, and (5) whether sex differences exist in the sustaining of attention

For the pursuit of this study, attention-span was defined simply as the time during which a given activity continues without external compulsion or persuasion, the time during which a subject manifests by overt behavior a continuance of this activity of his own accord

The subjects used in the investigation were 36 children, ranging in age from three years to five years and nine months There were 12 children at each year level—three, four, and five—with an even division as to sex in each group All of the subjects were enrolled

either in the prekindergarten or in the kindergarten of the Elementary School of Chicago Teachers College when the tests were conducted; the experimental data were gathered during the spring, summer, and fall of 1930 and 1931

In conformance with the definition of attention-span used as a basis for procedure, it was necessary to utilize experimental materials of a kind such as to present attractive possibilities to the child but the nature of which would not set up an activity having an obvious termination Rather than provide a goal-seeking situation, it was held essential to present materials which would lend themselves to a repetitive manipulation which would tend to perpetuate itself

The necessity was also recognized of keeping the experimental activities within the range of ability of the youngest of the subjects and yet not evoking any feeling of antagonism in the older children of the group examined due to presentation of "games" which they might resent as "baby" It was felt desirable to have a bright and colorful appearance a constant factor for all the materials utilized, and to have them all of a manipulative character The findings of Wagoner (49), of Bridges (30, 31), and of Herring and Koch (39) all indicate these factors to be most frequently noted in the spontaneous choices of play materials of preschool children Furthermore, such material was necessary as would not involve any intervention or assistance from the examiner but would permit of ready handling by the subject

The large mass of manipulative material available in toy and game houses was surveyed, and equipment was selected which seemed to fit the requirements of the proposed study The available material on the market was not thought to be wholly satisfactory for use in one section of the experiment, and the cooperation of one of the large Eastern toy houses was enlisted, from which material was obtained according to the writer's specifications

With the choice completed, three situations were arranged which lent themselves to presentation in two ways first, as a simple procedure involving merely repetitive movements and offering no possibilities of variation, and, secondly, as a more diversified performance, involving again the same repetitive movements, but presenting possibilities of a variety of approaches and methods of attack The actual procedure, then, entailed six different situations, arranged in pairs, of which one approach was designated as *simple,* the other as *complex.*

Exact details follow

Simple Situation 1—Placing Circles

Materials. An uncovered white cardboard box, 4½ x 7½ x 2½ inches, filled with circles, 1 inch in diameter, made of construction paper in six different colors.[1]

Directions: E: "See what we do with these" E starts a row of the circles across the table, placing three differently colored ones. "You do it."

Scoring Stop-watch record in minutes and seconds from initiation of procedure by S until manipulation ceases.

Data noted *a.* Selection of colors
b. Random placement, or even row.
c. Quality of attention intent, close, fair, wandering
d. Conversation, comments.

Complex Situation 1—Placing Pictures

Materials: An uncovered, white cardboard box, 4½ x 7½ x 2½ inches, filled (1) with a variety of geometric figures, 1 to 2 inches in size, made of colored construction paper, and (2) with an assortment of small colored pictures—kittens, birds, ducks, flowers, toys, etc—1½ to 2½ inches in size [2]

Directions E. "See what we have here" E starts a row of the pictures across the table, placing two different pictures and one geometric figure. "You do it."

Scoring As in Simple Situation 1, above.

Data noted: As in Simple Situation 1, above, plus
e. Choice of subjects, grouping by kind

Simple Situation 2—Dropping Pegs

Materials A covered, varicolored cardboard box, 4 x 7 x 4 inches, with a hole ⅞ of an inch square cut in the center of the top An uncovered, tan cardboard box, 4½ x 6 x 2 inches, filled with colored shoe-pegs, 1¼ inches long.[3]

Directions E "See what I can do." E drops three pegs, taking one at a time from the supply-box, through the hole in the cover

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[1]Made by the Harter Publishing Company, Cleveland, Ohio

[2]Figures from Harter Publishing Company, Cleveland, Ohio Pictures the usual scrap-book variety

[3]Made by the Ideal School Supply Company, Chicago, Illinois

of the other box. E shakes box to rattle pegs within it "You put some in."

Scoring As in previous situations

Data noted *a* Selection of colors
b Pegs taken singly or by handfulls
c Quality of attention: intent, close, fair, wandering
d Conversation, comments

Complex Situation 2—Dropping Assorted Forms

Materials: Box with hole in top, as in Simple Situation 2. An uncovered, blue tin box, 5½ x 8½ x 5 inches, filled with assorted forms—round, oval, and square beads, ½ inch in size, ¾-inch and 1¼-inch shoe-pegs, ¾-inch and 2-inch round pegs, 1-inch beaded pegs, parquetry forms, 3-16 of an inch thick, in triangular and diamond shapes, measuring 1 x 1½ and ¾ x 1¼ inches, respectively All forms colored [4]

Directions. E "See what I can do." E drops three forms, of different varieties, through hole, one at a time E shakes box to rattle contents "You put some in"

Scoring As in previous situations

Data noted As in Simple Situation 2, plus
e. Discrimination as to form

Simple Situation 3—Round Disks

Materials Round wooden standard, 4 inches in diameter, ⅝ inch thick, painted light green, a red wooden rod, 5½ inches long and ⅜ inch in diameter, inserted firmly in the base. Six successive bands of color, each ¼ inch wide, painted around the lower end of the rod. An uncovered, blue tin box, 7½ inches in diameter, filled with round wooden disks, each 3-16 of an inch in thickness, 2 inches in diameter, and with a hole ½ inch in diameter in the center All disks colored [5]

Directions Rod presented filled with disks. E: "See what I can do" Pours disks from rod into supply box, replaces standard on table, takes three disks, one at a time, and slips them on the rod, permitting them to slide down with a final "clack" E: "You put some on"

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[4]Made by the Ideal School Supply Company, Chicago, Illinois
[5]Made by the Schoenhut Company, Philadelphia, Pennsylvania

Scoring. As in previous situations

Data noted. *a.* Disks dropped singly, or several together

b Selection of colors.

c Quality of attention. intent, close, fair, wandering

d Conversation, comments.

Complex Situation 3—Assorted Disks

Materials Wooden standard, ⅞ inch thick, 10 inches square, painted light green, with five wooden rods, of same dimensions as in Simple Situation 3, inserted in the board, one in the center and one in each corner. At the base of each rod, painted on the standard in orange, a geometrical shape—square, triangle, diamond, circle, and oval, respectively. A 12-inch square box filled with disks of the same shapes and sizes as those painted at the base of the rods, the square with 2-inch sides, the triangle a 2½-inch isosceles figure, the diamond 2 by 3½ inches, the circle 2 inches in diameter, and the oval 2¼ by 3½ inches All disks 3-16 of an inch in thickness, all disks colored.[6]

Directions. Rods presented empty E· "See these." Slips two disks on corresponding rods "You put some on"

Scoring. As in previous situations

Data noted: As in Simple Situation 3, plus

e. Discrimination as to form

It is scarcely necessary to note that the directions are very simple and very brief, and that the scoring of the time of sustained attention presents no intricacies The writer did not consider it necessary to record the time in any finer degree than minutes and seconds, split-second recording would have had no material effect upon the resultant data

In the organization of the experimental situations, certain conditions were held constant throughout the study. Many of these factors were not emphasized or consistently observed in the previously reported observational studies, which may have influenced the obtained results. The present investigation, adhering rigidly to the conditions regulating the established procedure, provides data fairly comparable for the three groups of subjects. These conditions may be noted here

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[6]Made by the Shoenhut Company, Philadelphia, Pennsylvania

The same examiner made all the observations and measurements in the study The subjects were all familiar with the examiner, who was a frequent and accepted caller in the schoolrooms and on the playground

At no time was any child urged to "play games" (the customary approach) who showed the slightest hesitancy about leaving the play situation of the moment to go with the examiner Developments proved that no anxiety was necessary concerning the children's co-operation, the subjects were all not only willing to play the games, but were usually very eager for a "turn" In fact, the enthusiasm shown by the children sometimes brought them to the door of the examining room, also to the regular office of the examiner at most inconvenient times asking for more of the "nice games"

The room in which the experiment was conducted was familiar to all the subjects and was quite adequate for the purpose of the study Fifteen by 13 feet, well-lighted by three windows, it was fortunately situated in a corner of the school building away from the regular bustle of an elementary school in session

Material for the presented situation was the only "game" seen by a subject at one time. The remaining materials were easily accessible in a convenient wall-cabinet, but were not visible while an activity was in progress. The six colors were the same for each set of materials: red, orange, yellow, green, blue, and purple All were bright and attractive

In each case the "simple" and "complex" aspects of the situations were presented on different days, the former always preceding the latter.

In each visit to the examining room, the subject was seated in a comfortable small chair at a small table, 18 x 26 inches, so placed that the examiner was not in his line of vision The examiner sat at another table, slightly in back of and to one side of the subject, so that, while the latter was always clearly visible and each movement could be noted, the former was practically eliminated from the view of the child once the test situation was under way Once the directions were given and the subject commenced the "game" of the moment, the stop-watch was started and the examiner busied herself with writing in her notebook, no longer ostensibly interested in the subject

No other individual was ever present during any of the tests, and

TABLE 1

AVERAGE ATTENTION-SPAN FOR EACH AGE LEVEL IN SIMPLE AND IN COMPLEX SITUATIONS

Number of subjects	Age	Type of situation	Attention-span	Average deviation
12	3	simple	8′ 22″	4′ 32″
12	4	"	8′ 15″	4′ 17″
12	5	"	9′ 22″	3′ 15″
12	3	complex	11′ 2″	5′ 8″
12	4	"	12′ 55″	5′ 32″
12	5	"	11′ 14″	3′ 45″

since as far as possible the examiner was out of the picture during the subject's activity, any social aspect was almost completely eliminated Any attempt on the part of the subject to engage the examiner in conversation was met pleasantly but very briefly A friendly atmosphere was maintained, yet social exchange of comments was not encouraged and did not occur, although some of the children chattered considerably.

Experimentation was confined to the first two hours of the morning session, so that any possible fatigue effect from the daily school procedure was precluded

Each child was seen daily by the school physician, so that no physical indisposition was present in any case, perhaps to affect the subject's performance.

THE EXPERIMENTAL DATA

Upon the completion of the experimental procedure, the data were subjected to statistical treatment for interpretation Since the subjects of the investigation were evenly divided according to chronological age, and since each group consisted of an equal number of boys and girls, comparable attention-spans could be ascertained for the three age levels, and for the different sexes at each age level

The average of the time spent at the three simple situations was found for each child, as was the average of the time spent at the three complex situations This made it readily possible to calculate an average attention-span for both the simple and the complex situations, for each of the three groups. The average attention-spans for the three year levels may be seen in Table 1

It was somewhat surprising to find very little difference in the

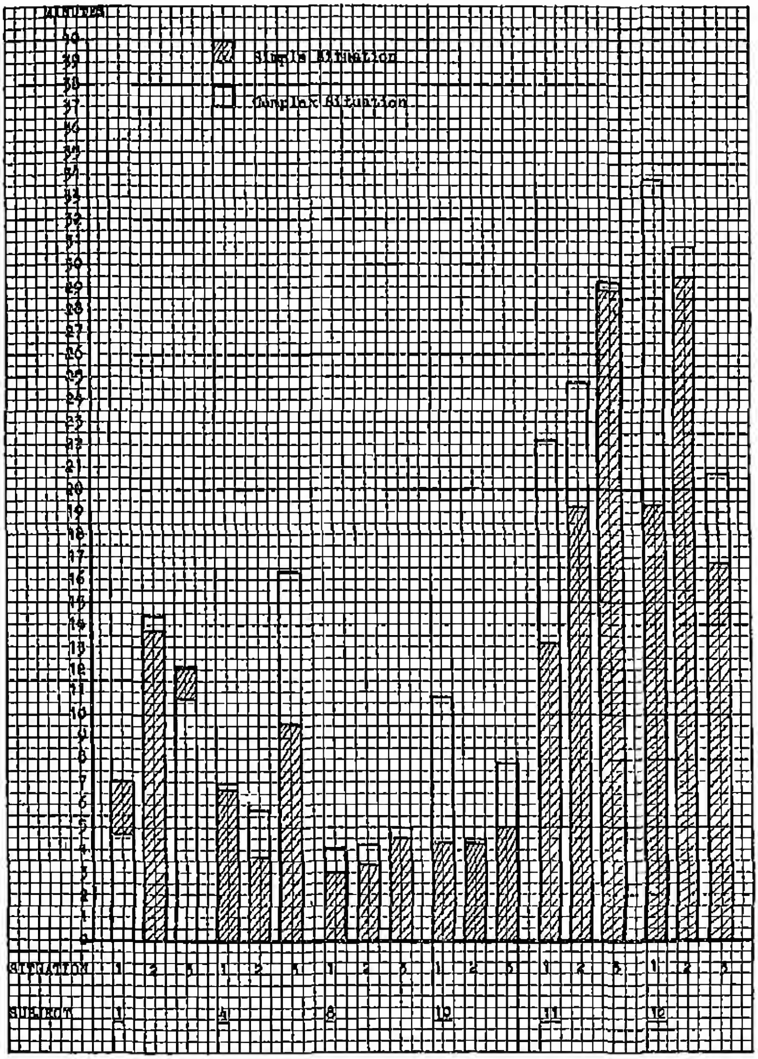

FIGURE 1
ATTENTION-SPAN OF EACH THREE-YEAR-OLD GIRL IN EACH SITUATION

actual time of sustained attention in the youngest and oldest of the groups. In fact, so slight a difference was found that it was considered insignificant. the three-year-old group averaged 8′ 22″, the four-year-old group averaged 8′ 15″, and the five-year-olds averaged 9′ 22″ These time records were in the simple situations. In the complex situations, the data show 11′ 2″, 12′ 55″, and 11′ 14″ for the three groups, respectively. The increase in time of sustained attention for the complex situations was consistently greater than that for the simple situations in all three groups, but the three groups spent very nearly the same time at each of the two approaches

The apparently negligible difference in the time of sustained attention for the three-, four-, and five-year-old subjects of the investigation prompted the experimenter to throw all the subjects into one

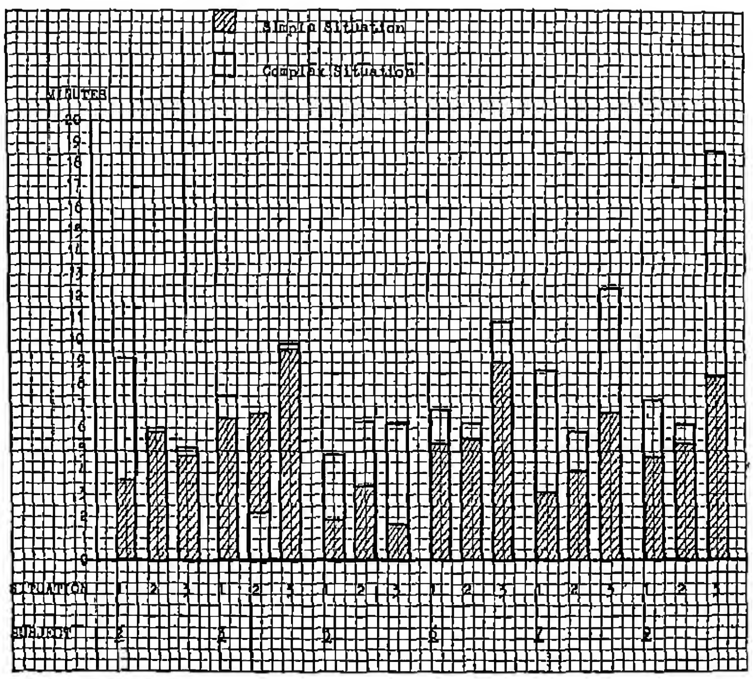

FIGURE 2

ATTENTION SPAN OF EACH THREE-YEAR-OLD BOY IN EACH SITUATION

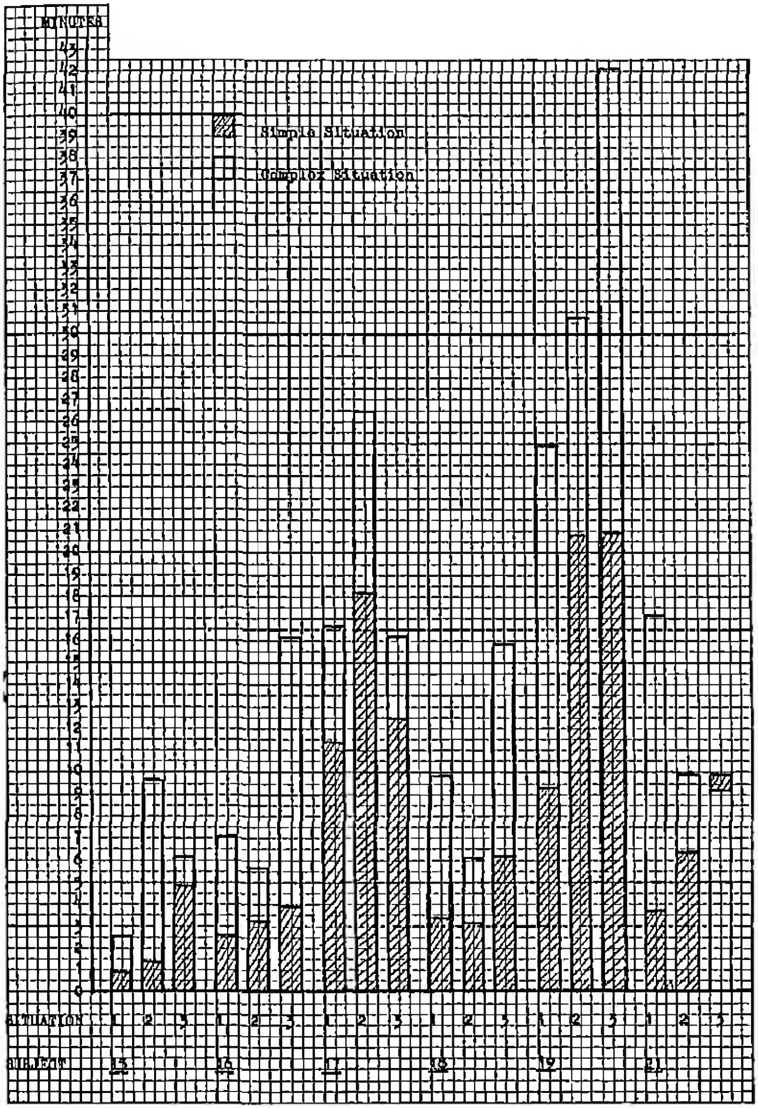

FIGURE 3
ATTENTION-SPAN OF EACH FOUR-YEAR-OLD GIRL IN EACH SITUATION

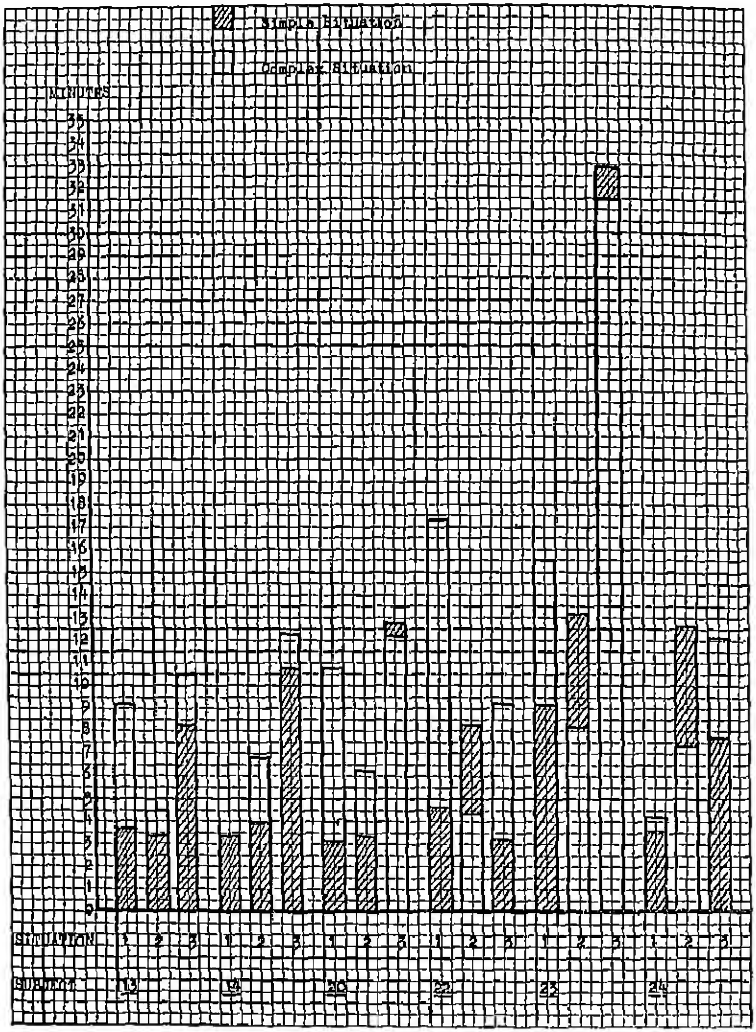

FIGURE 4
ATTENTION-SPAN OF EACH FOUR-YEAR-OLD BOY IN EACH SITUATION

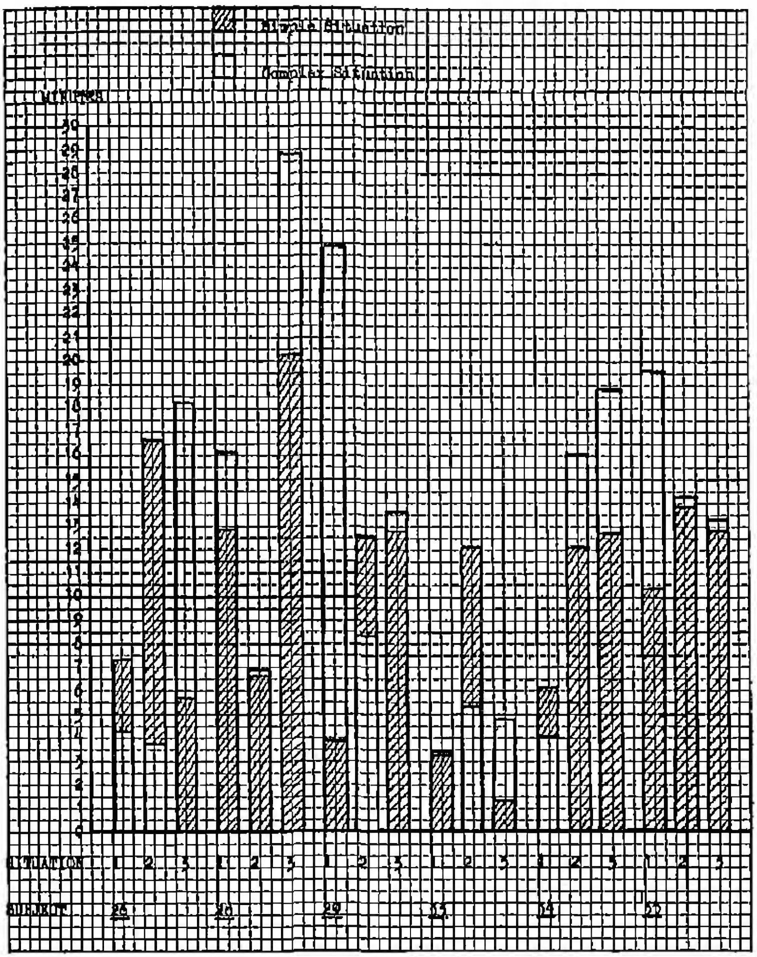

FIGURE 5
Attention-Span of Each Five-Year-Old Girl in Each Situation

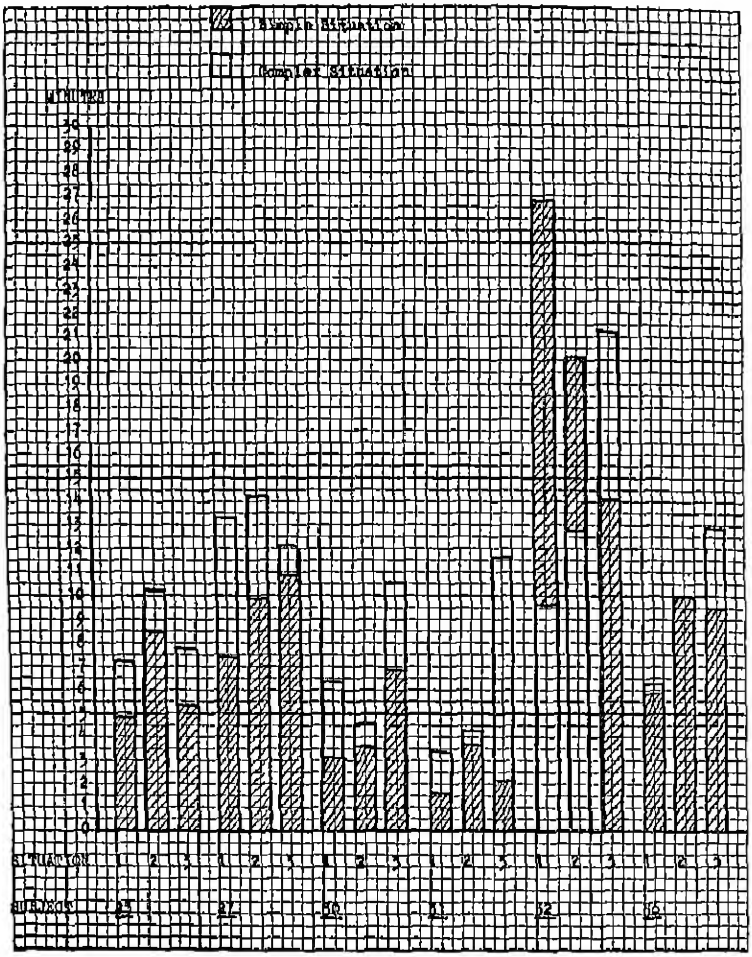

FIGURE 6
ATTENTION-SPAN OF EACH FIVE-YEAR-OLD BOY IN EACH SITUATION

TABLE 2

AVERAGE ATTENTION-SPAN FOR EACH AGE LEVEL ACCORDING TO SEX IN SIMPLE AND COMPLEX SITUATIONS

Number of subjects	Age	Sex	Attention-span in Simple situations		Attention-span in Complex situations	
				A D		A D
6	3	F	11′ 24″	6′ 20″	14′ 15″	8′ 13″
6	3	M	5′ 20″	1′ 30″	7′ 49″	1′ 20″
6	4	F	8′ 1″	5′ 6″	15′ 28″	7′ 26″
6	4	M	8′ 29″	3′ 20″	10′ 23″	2′ 20″
6	5	F	10′ 12″	1′ 33″	12′ 27″	3′ 47″
6	5	M	8′ 33″	4′ 33″	10′ 1″	2′ 53″

group as preschool children, rather than to consider the three groups as prekindergarten, junior, and senior kindergarten children.

Again averages were found of the time spent at both the simple and complex situations, and again a differentiation was fairly marked: the 36 subjects devoted an average of 8′ 39″ to the simple approach, and an average of 11′ 44″ to the complex approach In the simple situations the standard deviation was 5′ 20″, and the range extended from 2′ 19″ to 21′ 51″, in the complex situations, the standard deviation was 6′ 25″, and the range 4′ 26″ to 32′ 34″

The question of a difference in sustained attention in the sexes was next considered This was calculated for each age level The results were consistent in showing a longer period of sustained attention for the girls than for the boys, regardless of whether the simple or complex situations were considered. There was only one instance in which the time of sustained attention of the boys exceeded that of the girls, and here the difference was only 28″ in favor of the boys, this was at the four-year-level, and regarding the simple situations These data appear in Table 2

The three-year-old girls are here seen to have spent 6′ 4″ longer at the simple situations than did the three-year-old boys, and 6′ 26″ longer at the complex situations The four-year-old boys spent 28″ longer at the simple situations than did the girls of that age, but were exceeded by the girls at the complex situations by 5′ 5″ In the case of the five-year-olds, the girls spent 1′ 39″ more at the simple situations, and 2′ 26″ more at the complex situations, than did the boys. Figure 7 represents these differences graphically.

With this apparently steady decrease in the comparative times of attention-span for the three year levels, it is interesting to speculate whether the difference in sustained attention between the sexes approaches zero, and whether perhaps at later age levels the odds would be in favor of the boys

The results of the present investigation may be summarized briefly:

1 There was no appreciable difference in the time of sustained attention in three-, four-, and five-year-old children

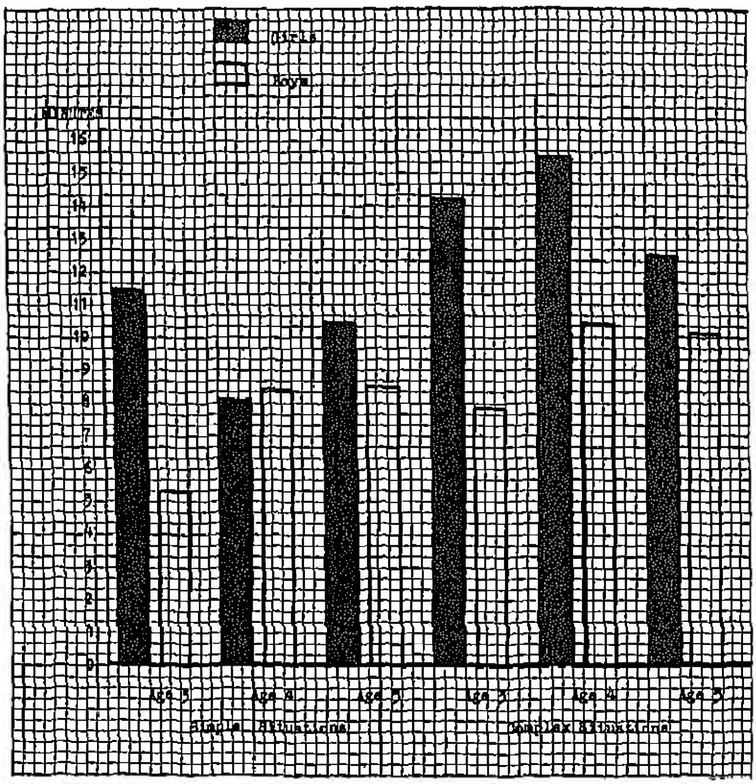

FIGURE 7
COMPARATIVE ATTENTION-SPANS OF GIRLS AND OF BOYS AT EACH AGE LEVEL IN SIMPLE AND COMPLEX SITUATIONS

2 Each age group showed a consistently greater attention-span for the complex situations as compared with that for the simple situations.

3 At each age level the girls showed a longer period of sustained attention than did the boys

4 With increasing age there was evident a decrease in the difference in time of attention-span for the sexes.

5. The average period of sustained attention for the preschool group examined was 8′ 39″ in the simple situations, the S.D was 5′ 20″, and the range 2′ 19″ to 21′ 51″

6 The average period of sustained attention for the preschool group examined was 11′ 44″ in the complex situations; the S.D. was 6′ 25″, and the range 4′ 26″ to 32′ 34″.

These findings are not in entire accord with the published conclusions of other investigators It may be of interest at this point to consider them in comparison with the results offered previously in the literature

The writer indicated that *no appreciable difference was found in the attention-spans of the three age levels studied*, and that the experiment suggested as reasonable the grouping of all preschool children, as showing brief periods of sustained attention, rather than the expectation of a greatly increased span of attention in five-year-old as compared with three-year-old children. The data show attention-spans of 8′ 22″, 8′ 15″, and 9′ 22″ for three-, four-, and five-year-old children, respectively, in the experimental situations designated here as "simple." In the complex situations, the three age groups sustained attention for periods of 11′ 2″, 12′ 55″, and 11′ 14″, respectively. Other writers note an increase of time of attention with increasing age greater than that shown in the present data.

Bertrand (21), in 1925, stated that his three-year-old subjects averaged 10 minutes at one activity, the four-year-old children, 16 minutes; and the five-year-olds, 25 minutes.

Bott (29), in 1928, reported, as spans of attention upon play materials, 2.5 minutes for two-year-olds, 4 7 minutes for three-year-olds, and 5.6 minutes for four-year-olds These were data gleaned from the observation of nine children, three in each age group mentioned, hardly a sufficiently large number of subjects from whose performance to draw generalizations.

Davidson (33), in 1931, mentioned a greater power of voluntary

attention at six as compared with four years of age, but offered no supporting evidence for this statement

Van Alstyne (48), in 1932, reported that observation of play activities of preschool children in three different schools showed that "the attention-span for play materials . . . practically doubles itself from the second to the fifth year" (p 37). The two-year-olds of this study were said to have averaged an attention-span of 6 9 minutes, the three-year-olds, 8 9 minutes, the four-year-olds, 11.4 minutes, and the five-year-olds, 12.6 minutes It is to be remembered that these "attention-spans" represented the time spent in play situations *with other children* of the preschool groups observed. The cooperative aspect must be taken into consideration, particularly since Van Alstyne reported that, of the three most popular play situations for all ages noted, viz., blocks, clay, and doll-corner (p. 30), the first and last of these were the materials which ranked highest in active cooperation (p 96). It was further suggested by Van Alstyne that bringing a child with a short span of attention into play with a child of long span may aid the former to lengthen his attention-span (p 89), a suggestion which increases the emphasis to be placed upon the fact that "attention-span" in social situations is not an individual's representative and actual attention-span.

Most interesting in this connection is the conclusion reached by Leontiev (23), in 1932, who, studying the development of voluntary attention in children, remains unconvinced of the ability of young children to sustain attention! His preschool subjects were five-year-old children, and numbered seven

The results of the present investigation also indicated that the *girls showed a consistently longer period of sustained attention than did the boys* The statements of other investigators concerning sex differences are sometimes in agreement and sometimes at variance with the findings of the writer, although they are not unequivocal, they yet tend to confirm the conclusions of the study here reported

Bertrand (21) stated that the four- and five-year-old girls under his observation showed longer periods of attention to play activities than the boys of those ages, but that at three years of age no difference in time was noted

Bridges (30), reporting on interests of three-year-old children, stated that the six boys of her observational study averaged about 7 minutes at any play activity undertaken, while the four girls observed averaged 9 minutes at one occupation

Goodenough (38), considering the behavior of young children during mental test situations, as rated by the examiners on a scale presumed to permit a highly objective classification, reported boys to be more "distractible" than girls.

Cushing (32), considering perseveration in preschool children, stated that the boys of the study showed a tendency to perseverate slightly longer than the girls, but noted that the findings were not completely reliable according to the statistical interpretation.

Herring and Koch (39) reported less sustained interest in girls than in boys, although they stated that the sex differences were not marked.

Van Alstyne (48), reporting on play activities, found the average attention on all play materials to be 9 5 minutes for girls and 8 7 minutes for boys.

In several observational studies of play activities of young children, notably those of Garrison (35), Loeb (41), Bridges (30, 31), and Herring and Koch (39), it was reported that boys prefer materials usable in active play, while girls incline toward more stationary occupations. Finer finger manipulation was also noted in the girls This difference in preference in materials and occupations must be borne in mind when the findings of the present investigation are considered, showing longer periods of sustained attention in the girls than in the boys It may well be that the experimental material here utilized appealed more to the girls than to the boys, with the aforementioned results—another instance of the danger of accepting on face value and in isolation statistical evidence unqualified by relative and perhaps influential data.

Summary and Conclusions

Since problems due to instability of attention arise with astonishing frequency, and since there has been available only conjectural commentary concerning the growth of the attention process in young children, this study was undertaken with the specific purpose of developing an experimental approach for studying the attention-span of preschool children, with particular emphasis upon ascertaining the following data (1) the possibility of stating a developmental level when there should be readiness for prolonged periods of sustained attention; (2) the establishing of whether or not periods of sustained attention show an increase paralleling successive preschool

age levels, (3) the influence of the complexity of the activity engaged in upon the time of sustained attention, and (4) the existence of sex differences in the sustaining of attention

For the pursuit of the investigation, attention-span was defined as the time during which a given activity continues without external compulsion or persuasion, the time during which a subject manifests by overt behavior a continuance of this activity of his own accord.

Thirty-six preschool children were the subjects, evenly divided not only as to sex but also as to numbers within the three age groups considered, three-, four-, and five-year levels Two kinds of activity were presented, designated as "simple" and as "complex," there being six different situations in the procedure Each situation utilized attractive material permitting unassisted manipulation by the subjects, scoring throughout was in units of minutes and seconds, recorded by means of a stop-watch.

Examination of the experimental data revealed that

1 The three-year-old subjects averaged an attention-span of 8′ 22″ in the simple situations, and 11′ 2″ in the complex situations

2. The four-year-old subjects averaged an attention-span of 8′ 15″ in the simple situations, and 12′ 55″ in the complex situations.

3 The five-year-old subjects averaged an attention-span of 9′ 22″ in the simple situations, and 11′ 14″ in the complex situations

4 The entire group of preschool children examined, comprising the subjects noted in (1), (2), and (3) above, averaged an attention-span of 8′ 39″ in the simple situations, with an S D of 5′ 20″, and a range of 2′ 19″ to 21′ 51″

5 The entire group of preschool children examined, comprising the subjects noted in (1), (2), and (3) above, averaged an attention span of 11′ 44″ in the complex situations, with an S D of 6′ 25″, and a range of 4′ 26″ to 32′ 34″

6 The girls at each age level showed a longer period of sustained attention than did the boys. With increasing age, the difference between the sexes in attention-span decreased

7. There was consistent evidence of shorter periods of sustained attention for the simple situations than for the complex situations, regardless of the sex of the subjects

These results permit the statement of the following conclusions, found to exist within the limitations of the present investigation·

1 There is no significant difference in the time of sustained attention in three-, four-, and five-year-old children. Preschool chil-

dren may be considered as a unit group in reference to attention-span

2. Preschool children may in general be expected to sustain attention within a range of 8 to 12 minutes, depending upon the complexity of the activity engaged in Individual differences will, of course, always be apparent

3 Girls show a longer period of sustained attention than do boys with the type of materials utilized With increasing age, there is a decrease in the difference between the sexes in regard to attention-span

Despite its limitations—the most obvious of which are the comparatively small number of subjects and the restriction of subjects to young children with school experience—the writer feels that the present experimental approach to the investigation of attention-span in preschool children at least serves to lift this acknowledged problem from its previous conjectural basis to a level of scientific inquiry, and that the study may serve to stimulate further investigation of sustained attention in young children

References

To facilitate ready reference this list of references is sectioned to indicate references (1) to theories and methods of measurement of attention, (2) to investigations of attention of preschool subjects, and (3) to studies of child development.

Section 1 Theories and Methods of Measurement of Attention

1 Baldwin, J M Dictionary of philosophy and psychology Vol. 1 New York Macmillan, 1905 Pp xxiv+644

2. Boring, E. G A history of experimental psychology New York Century, 1929 Pp 699

3 Burnham, W H Attention and interest *Amer J Psychol*, 1908, **19**, 14-18

4 ————. The normal mind New York Appleton, 1924 Pp 702

5 Dallenbach, K M The measurement of attention *Amer J Psychol*, 1913, **24**, 465-507

6. ———— Attention *Psychol Bull*, 1926, **23**, 1-18

7 ———— Attention *Psychol Bull*, 1928, **25**, 493-512

8 Ebbinghaus, H Grundzuge der Psychologie Vol 1 Leipzig: Veit, 1911 Pp viii+811

9 Geissler, L R The measurement of attention *Amer J Psychol*, 1909, **20**, 473-529

10 Henning, H Die Aufmerksamkeit Berlin Urban & Schwartzenberg, 1925 Pp vii+212

11 JAMES, W The principles of psychology Vol 1 New York. Holt, 1893 Pp xii+689

12. JOHNSON, H M Definition and measurement of attention. *Amer J. Psychol.*, 1925, 36, 610-614

13 OBERSTEINER, H Experimental researches on attention *Brain*, 1879, 1, 439-453.

14. PILLSBURY, W. B Attention New York Macmillan, 1908 Pp 346

15 ——— Essentials of psychology New York Macmillan, 1926 Pp 428

16 RIBOT, T The psychology of attention (Trans) Chicago Open Court, 1903 Pp 120

17 TITCHENER, E B Feeling and attention New York Macmillan, 1908 Pp 404.

18 WOODROW, H The measurement of attention *Psychol Monog.*, 1914, 17, No 76. Pp 158

19. ——— The faculty of attention *J Exper Psychol*, 1916, 1, 285-318

20 WUNDT, W Principles of physiological psychology (Trans by E B Titchener) New York Macmillan, 1904 Pp xvi+347.

Section 2 Measurement of Attention of Preschool Subjects

21 BERTRAND, F L Contribution à l'étude psychogénétique de l'attention. *Année psychol.*, 1925, 26, 155-158

22. BROWN, M Continuous reaction as a measure of attention. *Child Develop*, 1930, 1, 255-291

23 LEONTIEV, A N. The development of voluntary attention in the child *J Genet Psychol*, 1932, 40, 52-81

24 WALLON, H Les causes psycho-physiologiques de l'inattention chez l'enfant *Bull. Soc fr. de péd*, 1929, 32, 8-15.

Section 3 Developmental Studies of Children

25 ANDERSON, J E, & GOODENOUGH, F L. Your child, year by year New York· Cupples & Leon, 1930. Pp 371

26 ANDRUS, R An inventory of the habits of children from two to five years New York Columbia Univ, Teach Coll, Bur. Publ., 1928 Pp 51

27 BALDWIN, B T., & STECHER, L I The psychology of the preschool child New York: Appleton, 1927 Pp 305

28 BINET, A Les idées modernes sur les enfants Paris Flammarion, 1909 Pp. 346

29 BOTT, H Observation of play activities in a nursery school *Genet Psychol Monog*, 1928, 4, 44-88

30 BRIDGES, K M. B Occupational interests of three-year-old children *J Genet Psychol*, 1927, 34, 415-423

31 ——— Occupational interests of four-year-old children. *J Genet Psychol*, 1929, 36, 551-569

32 CUSHING, A M A perseverative tendency in preschool children *Arch Psychol*, 1929, 17, No. 108 Pp 55

33. DAVIDSON, H P. An experimental study of bright, average, and dull children at the four-year mental level. *Genet Psychol Monog*, 1931, 9, 125-289

34 FARWELL, L. Reactions of kindergarten, first-, and second-grade children to constructive play materials *Genet Psychol Monog*, 1930, 8, 431-562

35 GARRISON, C G Permanent play materials for young children New York. Scribner's, 1926 Pp 122

36 GESELL, A The mental growth of the preschool child New York. Macmillan, 1925 Pp 447

37 ——— Infancy and human growth New York Macmillan, 1928. Pp 418.

38 GOODENOUGH, F. L. The emotional behavior of young children during mental tests *J. Juv Res*, 1929, 13, 204-219.

39 HERRING, A, & KOCH, H A study of some factors influencing the interest span of preschool children *J Genet Psychol.*, 1930, 38, 249-275.

40 INSKEEP, A D Child adjustment in relation to growth and development New York Appleton, 1930 Pp 427

41 LOBB, J. An experiment in a public school kindergarten *Kindergarten & First Grade*, 1920, 5, 58-63

42 MOORE, E S The development of mental health in a group of young children an analysis of factors in purposeful activity *Univ Iowa Stud Stud Child Welfare*, 1931, 4, No. 6. Pp 128

43 MURCHISON, C [Ed] A handbook of child psychology Worcester, Mass Clark Univ. Press, London Oxford Univ Press, 1931 Pp xii+711

44 NATIONAL SOCIETY FOR THE STUDY OF EDUCATION Twenty-eighth yearbook, ed. by G M Whipple Bloomington, Ill Pub. School Publ Co, 1929 Pp. 875

45 NELSON, J. F. Personality and intelligence New York Columbia Univ, Teach. Coll, Bur Publ, 1931. Pp 62

46 STERN, W Psychology of early childhood New York Holt, 1924 Pp 557

47. TILSON, M A Problems of preschool children *Teach Coll Contrib Educ*, 1929, No 356. Pp. 90

48 VAN ALSTYNE, D Play behavior and choice of play materials of preschool children Chicago Univ Chicago Press, 1932 Pp 100

49 WAGONER, L C The constructive ability of young children *Univ Iowa Stud Stud. Child Welfare*, 1925, 3, No 2, 7-53

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UNE MÉTHODE POUR LA MESURE DE L'ATTENTION SOUTENUE DES ENFANTS D'ÂGE PRÉSCOLAIRE

(Résumé)

On a fait cette étude dans le but de développer une approche expérimentale à l'étude de l'etendu de l'attention chez les enfants d'âge prescolaire Pendant cette etude, on a defini l'etendu de l'attention comme le temps pendant lequel un sujet manifeste par son comportement clair la continuation d'une activité de sa propre volonté On a enregistré les résultats en termes de minutes et de secondes

Le processus expérimental a utilisé trois paires de situations, dont chacune a été possible de presenter de deux façons différentes, c'est-à-dire, d'abord, comme un processus simple comprenant simplement des mouvements répétés, n'offrant nulles possibilités de variation, ensuite, comme un processus plus diversifie, comprenant encore les mêmes mouvements répétés, mais presentant des possibilités d'une variété d'approches et de methodes d'attaque. Chacune de ces six situations a utilisé du matériel séduisant qui a permis aux sujets une manipulation non aidée Les sujets ont éte trente-six enfants, âges de trois, de quatre, et de cinq ans

Les résultats ont indiqué (1) qu'il n'existe aucune différence signifiante dans le temps de l'attention soutenue chez les enfants âgés de trois, de quatre, et de cinq ans; (2) que les enfants d'âge préscolaire peuvent en général soutenir l'attention pendant une periode de huit à douze minutes, dépendant de la complexité de l'activité en jeu, avec les différences individuelles toujours visibles, et (3) que les filles montrent une plus longue période d'attention soutenue que les garçons avec le type de matériel utilisé, mais avec l'avancement de l'âge on note une plus petite difference entre les sexes dans l'etendue de l'attention

SHACTER

EINE METHODE ZUR MESSUNG DER ERHALTENEN AUFMERKSAMKEIT BEI VORSCHULPFLICHTIGEN KINDERN

(Referat)

Das Ziel dieser Untersuchung war die Entwicklung einer experimentellen Annaherungsweise zur Erforschung der Spanne der Aufmerksamkeit [attention span] bei vorschulpflichtigen Kindern. Fur die Zwecke der Untersuchung wurde die Spanne der Aufmerksamkeit definiert als die Zeit wahrend der die Versuchsperson durch ihr ausserliches Benehmen die willkurliche Fortsetzung einer Tatigkeit erweist Es wurde der Zeitverlauf in Minuten und Sekunden notiert

Im experimentellen Verfahren wurden drei Situationspaare verwendet, worin jede Situation sich auf zwei verschiedene Weisen darbieten liess—namlich zuerst als eine einfache, nur immer wiederholte Bewegungen in Anspruch nehmende, keine Moglichkeit der Variierung darbietende Tatigkeit, und zweitens als ein mehr mannigfaltiges Verfahren worin die selben immer wiederholten Bewegungen in Anspruch genommen wurden, worin aber die Moglichkeit verschiedener Annaherungsweisen und Angriffsweisen dargeboten wurde. In jeder dieser sechs Situationen wurde anziehendes, selbstandige Behandlung durch die Vpp ermoglichendes, Material verwendet Als Vpp. dienten 36 Kinder, 4, 5, und 6 Jahre alt

Die Befunde wiesen darauf hin, dass (1) kein bedeutender Unterschied in der Dauer des gespannten Aufmerksamkeit bei 3-, 4-, und 5-jahrigen Kindern besteht, (2) dass man im Allgemeinen erwarten kann, dass vorschulpflichtige Kinder die Aufmerksamkeit wahrend 8 bis 12 Minuten gespannt erhalten konnen, je nach der Kompliziertheit der betriebenen Tatigkeit, und unter vortwahrander Erscheinung der individuellen Unterschiede; und (3) dass Madchen eine langer Periode der angespannten Aufmerksamkeit erweisen als Knaben, in Bezug auf die verwendeten Gegenstande Der Unterschied zwischen den Geschlechtern in Bezug auf die Dauer der Aufmerksamkeitsspannung nahm mit zunehmendem Alter sichtbar ab

SCHACTER

AN EXPERIMENTAL STUDY OF THE SOCIAL BEHAVIOR STIMULATED IN YOUNG CHILDREN BY CERTAIN PLAY MATERIALS*

From the Child Welfare Research Station of the State University of Iowa

Ruth Updegraff and Edithe K Herbst[1]

The Problem

Studies relating to the value and use of play materials by young children have been primarily concerned with the frequency of use as an index of preference, although occasional work has been reported on the influence of play materials on motor, mental, and physical development. That some materials are of more value in encouraging sociable play than are others has frequently been stated by teachers of young children without experimental evidence, however The present study was an attempt to observe under experimental conditions certain aspects of social behavior occurring during play limited to one variety of play material at a time. More specifically, the problem was to study (1) the types of social behavior observable when two children are provided with blocks or clay as play material, and (2) any variations in these types corresponding to age differences Social behavior was defined as behavior which is in response to the presence or behavior of another individual, this definition did not include responses to rules of behavior involving other persons since such behavior was not observable under the conditions of experiment

Related Investigations

Although the existence of a relationship between a child's play material and his behavior has been pointed out by several authorities, there have been only a few studies contributing pertinent evidence It is quite possible that certain play materials do encourage social

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[1]This study, directed and reported by the first author, was carried out by the second author. Miss Josephine Smith aided materially in a portion of the statistical work

play more than others. According to Bridges (1) a definite advance has taken place in a child's social development when he becomes more interested in another child than in the exclusive possession or use of a certain material Hulson (3), in the course of her study of free activity of four-year-olds, developed an index of social value for materials, this index was determined by the average number of children playing together with each given material In Van Alstyne's recent study (5) she reports observations of uses to which play materials were put, together with records of social interaction, basing her judgment of social value on (1) amount of conversation and (2) amount of cooperation The criteria employed in both studies indicated that blocks as a material stand high in "social value." This bears out Garrison's statement (2) "blocks . afford *through their use the greatest opportunity for the development of* cooperative thinking and acting." Hulson and Van Alstyne obtained similar results and also stated that clay and plasticine are low in social value, although this interpretation for the latter author rests on the criterion of a low score in "active cooperation "

Because of the concurrence of evidence that places blocks and clay at opposite ends of the scale of social value, these two materials were chosen for more extensive and intensive analysis from the standpoint of the social behavior stimulated during their use

Subjects

The subjects were 28 children, 17 boys and 11 girls, in daily attendance in two of the preschool laboratories of the Iowa Child Welfare Research Station. Seven boys and 7 girls in the first group ranged in age from two years, six months to three years, two months, while 4 girls and 10 boys in the second group were from three years, four months to four years, two months of age

Procedure

Preliminary Experiment In order to limit distractions and to control the number of children playing at one time, as well as the amount of play material, it was planned to make obseravtions of two children in an experimental room Accordingly, a preliminary experiment was undertaken in which the total time of the period was varied and a checking blank for immediately classifying behavior was developed and tried out As a result of the preliminary work, it seemed evident that· (1) all the children were interested, (2)

OBSERVATION OF SOCIAL BEHAVIOR WITH PLAY MATERIALS
in
PAIRED EXPERIMENTAL GROUPS

Date__________

A__________ Group_____ Material__________ Age__________

B__________ Group_____ Time__________ Observer__________ Age__________

	1st Minute				2nd Minute				3rd Minute				4th Minute				5th Minute			
	1-15		30-45		1-15		30-45		1-15		30-45		1-15		30-45		1-15		30-45	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
1. Plays independently																				
2 No observable attention to other																				
3. Plays near other																				
4. Watches other																				
Verbally suggests																				
5. New use of material																				
6. Mutual activity with combined material																				
7. Mutual activity each with own material																				
8. Mutual activity unrelated to material																				
Response to suggestion																				
9. No overt response																				
10. Attempts to comply																				
11. Refuses to comply																				
12. Makes counter suggestion																				
13. Imitates other's activity																				
Conversation																				
14. Monologue																				
15. Concerning material																				
16. Concerning use of material																				
17. Concerning unrelated matter																				
18. Suggests other give up material																				
19. Unsuccessful attempt to take other's material																				
20. Successful attempt to take other's material																				
21. Gives material to other without suggestion																				
22. Exchanges material																				
23 Through action suggests 5, 6, 7, or 8																				

FIGURE 1
THE OBSERVATION BLANK

a total period of five minutes was feasible since this length of time gave each child opportunity to become interested in the materials as well as in the other child, but did not permit him to tire of the game, (3) the behavior should be observed for fifteen seconds and checked during the following fifteen-second interval; and (4) the blank was adequate for checking the behavior under such conditions

Observation Blank In constructing this blank (Figure 1) the purpose was to provide adequately for all behavior in the situation which might be classed as either positively or negatively social It was necessary to make provisions both for the use of the material and for its non-use Behavior had to be described in objective terms. The list of items of necessity was to be short enough so that it could be kept in mind by the recorder. Since two children were to be observed simultaneously, provision for the recording of interaction, suggestion, and response was essential. The definitions are as follows

1 *No use of material*

Is engaged in some activity which is not related to the material provided by the experimenter He may be playing alone or with another child, but if the latter, he is not playing with provided material, if the former, he has no interest in B's material He may be engaged in physical activity

2 *No observable attention to other*

Pays no attention to partner, does not look at him, touch him, or converse with him for a period of about five seconds

3 *Plays near other*

Plays within a distance of about two feet or less from partner They may or may not be aware of each other Under some circumstances they may be standing but usually they will be seated on the floor with a distance of two feet or less between them for five seconds or more

4. *Watches other child*

Looks at partner or what partner is doing continuously for a period of at least five seconds

5 *New use of material*

Suggests use of material which is a different use of that particular material from any preceding uses in that period

6 *Mutual activity with combined material*

One child suggests that both put material together and play cooperatively

7. *Mutual activity each with own material*
   Tells partner what to do with his play material while he is playing with his own.
8. *Mutual activity unrelated to material*
   Ignores material provided by experimenter and suggests partner join him.
9. *No overt response*
   Does not look at partner, does not talk to partner, does not look at partner's material. Shows in no way that he has seen or heard what partner suggested
10. *Attempts to comply*
   Attempts to comply to partner's suggestion through manipulation of material or verbal response, by looking at partner or partner's material, or doing as partner asked.
11. *Refuses to comply*
   Refuses to comply to other's suggestion. May refuse verbally or may not comply but show that he has heard
12. *Makes counter suggestion*
   To partner's suggestion makes another suggestion of his own.
13 *Imitates other child's activity*
   Does what he sees the other child do without a suggestion
14. *Monologue*
   Talks or sings to himself without looking at other child
15. *Conversation concerning material*
   Makes remark directed to partner about the material, not pertaining to its use.
16. *Conversation concerning use of material*
   Makes remark about the way the toy is or can be used
17. *Concerning unrelated matters*
   Talks about something not pertaining to the provided material, may be about himself or objects in the room or outside.
18 *Suggests other give up material*
   Verbally tells or asks child to give up the provided material, without touching it
19. *Unsuccessful attempt to take other's material*
   One child attempts to take other's material by putting his hands directly on the toy or pushing, pulling, or holding other child to get the material, does not succeed.
20. *Successful attempt to take other's material*
   Same as above but succeeds.

21 *Gives material to other without suggestion*

Gives material to other child willingly without previous suggestion

22 *Exchange material*

Willingly exchanges materials without suggestion

23 *Through action suggests 5, 6, 7, or 8*

By manipulating his material in a new way (new for that period, for provided material) and looking at partner he is suggesting number 5

By manipulating his material close to partner and looking at partner he is suggesting 6 (This might follow a verbal suggestion during a previous interval)

By manipulating his material and looking at partner he is suggesting 7

By leaving his material and doing something unrelated to material, looking at partner at the same time, he is suggesting 8

24 *Conflict*

Instances of conflict not related to material

25. *Cries*

Child sheds tears, face flushes, corner of mouth is drawn down

In order to determine the reliability of the blank as a medium for the observation of the children's behavior and to make sure of the consistency of the observer, before the main experiment was begun the observer and one other person simultaneously observed 21 pairs of children, each pair for five minutes This yielded a total of 483 items The total number of identical checks constituted the number of agreements, while each instance in which one observer checked an item not noted by the other constituted a disagreement, this procedure weighted disagreements so that reliability thus determined was an underestimation For the 483 items there was an 85% agreement The items were then studied to determine where the disagreements were greatest, and 11 more pairs of children were observed Of the 253 items in this period, there was agreement in 240, or 94 8% of the instances

Materials Two sets of 36 blocks each, cubes and odd shapes, unpainted and varying in size, were used Two balls of gray clay about the size of teacups were made from clay powder. Two clay boards, size 12 by 12 by 1 inch, painted a light green, made up the remainder of the equipment

Experimental Period. The two children to be observed were

taken into a testing room in the same building as their playroom. For the first group the room was 8¾ by 6 feet and for the second group, 8¾ by 7 feet; in each room there were two windows and one door Aside from wall shelves there was no material other than that incidental to the experiment. Observations were made through one-way screens. Each child was paired with two boys and two girls.[2]

When the pair of children entered the testing room with the experimenter, the blocks were on the floor in two identical piles three feet apart (When clay was used the clay boards were separated by the same distance) The following instructions were given, "Here are some blocks (or clay) for you to play with until I return for you in a few minutes" The stop-watch was started The observer watched for the first 15 seconds, checked the behavior observed during that time in the second 15 seconds, observed the third 15 seconds, and so on

Pairs were alike for blocks and clay One-half of the pairs played first with clay, the other half played first with blocks No child played twice on the same day Each child was paired only with children in his or her own group In the first group no child served as subject more than four times for each material In the second group, due to the larger number of boys, the girls were paired seven times and the boys four times

Results

When the 28 children participating in the experiment were paired acording to the required conditions, there resulted a total of 28 pairs of two-year-olds and 34 pairs of three-year-olds In order to treat the two age groups comparably and to contrast the behavior of the children with the two materials, the data were treated as follows: The mean number of occurrences per pair of each behavior item on the blank was computed for each material for the first and second groups separately. Significant differences occurring in the frequency of a kind of behavior with either different materials or different ages were, therefore, indicative of behavior differentiations

From a study of the results as a whole, it is apparent that certain types of behavior occurred more often than others. The children spent much time playing near each other, watching each other, and

[2]The only bases for selection were those of sex and Extroversion-Introversion scores according to the Marston Rating Scale. The average of the E-I scores of all the children with whom any child was paired lay within the normal range

talking with each other concerning the material with which they were playing Although there was some variation in behavior with change of partners, this variation was not so great as might have been expected. For instance, the results do not show that during one experimental period a child paid no observable attention to the other child, while during another period he watched his partner for a major portion of the time

Differences in Behavior with Clay and Blocks

Two-Year-Old Children When the play of the first group with clay and blocks is compared by single behavior items (Table 1), there is only one difference quantitatively large These children watched their partners more while playing with clay than while playing with blocks It seemed that they had a special desire for watching others manipulate clay, perhaps, on the whole, it involves more variety and more interesting manual activity. In addition, there was a possible significantly greater number of verbal suggestions given to the partner for new use of his material in the case of clay than in the case of blocks.

Conversation, which is considered by some writers as evidence of good social contact between young children, was prevalent between the subjects While two-year-old children were playing with clay, 64% of the conversation (Items 15, 16, 17) concerned this material, 70% concerned blocks when they were used. Evidently the children were considerably interested in the material with which they were playing Further evidence for this is the fact that 78 and 60% of the verbal suggestions for clay and blocks respectively were toward new uses of the materials, this is good indication for the stimulating value of both materials.

For sociability to develop satisfactorily in children, it is necessary that they learn to give and take suggestions while playing with others. In order to find out whether clay would encourage interplay of suggestion and response more than blocks or vice versa, the total number of times verbal suggestions occurred and the types of ensuing response, whether positive (Items 5, 6, 7, 8, 10, 12) or negative (Items 9, 11), were compared (Table 1) No important differences were apparent

Three-Year-Old Children. From a strictly statistical point of view, there was little difference between the behavior exhibited by three-year-old children while playing with blocks and clay (Table 2) There are 98 chances in 100 that the children watched their partners more often when playing with clay than when playing with

TABLE 1

FREQUENCY OF OCCURRENCE OF CERTAIN TYPES OF SOCIAL BEHAVIOR EXHIBITED BY TWENTY-EIGHT PAIRS OF CHILDREN IN GROUP I PLAYING WITH CLAY AND BLOCKS

Item	Clay			Blocks			Ratio of difference to standard deviation of difference
	Frequency	Mean	Standard deviation	Frequency	Mean	Standard deviation	
1	45	1 61	3.24	71	2 53	4 37	74
2	100	3.57	3.77	112	4 00	4 09	41
3	198	7 07	7.86	232	8 28	6 82	62
4	257	9.18	4 27	181	6 46	2 37	2.94
5	86	3 07	2.25	55	1.96	1.12	2 36
6	2	07	25	10	36	61	2.23
7	6	21	55	12	43	73	1 10
8	16	57	90	11	.39	67	86
9	28	1 00	1.21	28	1 00	1 13	0 00
10	55	1.96	1 61	48	1 71	1 58	.60
11	12	43	72	18	64	1 04	88
12	18	64	85	9	32	66	1 60
13	33	1 18	1.20	21	75	95	1 48
14	33	1.18	1 67	40	1 43	2 13	49
15	144	5 14	4 48	161	5 75	4 98	48
16	12	43	1 35	11	39	1 08	01
17	85	3 03	3 30	73	2 61	3 04	50
18	3	11	39	15	.53	78	2 47
19	1	03	.15	0	0 00	0 00	1 00
20	1	03	15	10	36	61	2 75
21	1	03	15	9	32	66	2 42
22	1	03	15	2	07	25	66
23*a*	27	96	98	23	82	85	58
23*b*	10	.36	72	6	21	67	79
24	2	07	37	2	07	.37	0 00
25	2	07	37	0	0 00	0 00	1 00
5, 6, 7, 8	110	3.93	2 37	88	3.14	2 06	1 30
10, 12	73	2 32	1 95	57	2 04	1 90	53
9, 11	40	1.39	1.29	46	1 57	1 50	48

TABLE 2

FREQUENCY OF OCCURRENCE OF CERTAIN TYPES OF SOCIAL BEHAVIOR EXHIBITED BY THIRTY-FOUR PAIRS OF CHILDREN IN GROUP II PLAYING WITH CLAY AND BLOCKS

	Clay			Blocks			
Item	Frequency	Mean	Standard deviation	Frequency	Mean	Standard deviation	Ratio of difference to standard deviation of difference
1	21	62	1.21	24	70	1 52	24
2	32	94	1.23	63	1 85	3 37	1 47
3	232	6 82	6 43	205	6 03	7 08	48
4	250	7 35	4 98	172	5 06	3 52	2 17
5	150	4 41	3 13	127	3 73	1 58	1 48
6	5	15	40	16	47	88	1 88
7	27	79	93	30	88	1 21	35
8	17	50	85	11	32	63	95
9	33	97	1 18	32	94	87	12
10	104	3 06	1 64	78	2 29	1 65	1 93
11	13	38	80	30	88	1 08	2 10
12	52	1 53	1 19	59	1 73	1 36	65
13	27	79	1 37	17	.50	81	1 04
14	22	65	1 16	28	82	2 24	39
15	421	12 38	4 34	401	11 79	5 11	51
16	17	50	1 42	36	1 06	2 20	1 24
17	126	3 70	3 49	94	2 76	3 09	1 18
18	8	.23	.48	9	.26	60	.23
19	0	0 00	0 00	0	0 00	0 00	0 00
20	3	09	.29	2	06	.24	50
21	3	09	29	5	15	36	75
22	3	09	.38	0	0 00	0.00	1 29
23*a*	15	.44	.60	15	44	60	0 00
23*b*	10	.29	61	5	15	44	1 00
24	0	0 00	0 00	0	0 00	0 00	0 00
25	0	0 00	0 00	0	0 00	0 00	0 00
5, 6, 7, 8	199	5 79	2 02	184	5 41	2 29	49
10, 12	156	4 59	1 97	137	4 03	1.90	1.17
9, 11	46	1 26	1 27	62	1 71	1 30	1 45

blocks Since this was found also to be true with two-year-old children, the chances are that this point is important There is a possibility that there were more counter suggestions made while playing with blocks, this fact is interesting from the standpoint of the encouragement of give and take between the children.

That comparisons of behavior item frequencies did not in every case yield reliable differences from a statistical standpoint does not preclude the possibility of further analysis. It may be permissible to study the data critically to discover less definite tendencies toward differentiation.

The larger frequencies for some of the items were in the same direction for both the two- and three-year-olds, and there were fairly high possibilities of there being true differences For these two reasons the differences seem worthy of mention. There were more occurrences with blocks than with clay of mutual activity with combined material, of mutual activity each child using his own material, and of refusals to comply with the partner's suggestions There were more occurrences with clay than with blocks of mutual activity unrelated to material, of attempts to comply with the partner's suggestion, of imitation of the other's activity, and of conversation concerning unrelated matters.

From a consideration of separate behavior items, then, it appears that clay encourages watching and imitating activity, and that, while playing with this material, children are willing to take suggestions and are apt to start unrelated conversation and activity Possibly, this may mean that clay as a material is not so interesting to the children It is true that clay calls forth more verbal suggestions for its use than do blocks, and these suggestions are more often complied with. Perhaps this is indicative of the children having less decided and independent ideas of what to do with the material On the other hand, blocks seemed to foster more mutual activity when the children use them together and separately There were more cases of counter suggestions given in return for suggestions concerning blocks, and more instances of refusals to comply with suggestions. These facts probably should receive consideration in light of the findings that suggestions made while playing with clay were more readily complied with. Is it possible that the children are more familiar with blocks and, whether familiar or not, like them better and have more ideas of their own concerning how they wish to use them? Blocks may be used more creatively and persistently at these early years

Frequency of Certain Items Indicating Sociability and Cooperativeness Sociability and cooperativeness are two valuable personality traits to be encouraged They are two aspects or social behavior which are important to develop to some extent at least. It seemed of value, therefore, to study these data to the end of discovering whether one of the two materials would give more encouragement than the other to those types of behavior which might be considered examples of sociability and cooperativeness

Sociability was defined as that quality in an individual which makes him display an interest in the activity of others, a desire to seek their companionship and to make contacts with them In order to determine which of the behavior items listed on the observation blank were examples of this type of behavior, five staff members were asked to rate the behavior items on a scale of five, ranging from —2 to +2, according to their importance for furthering sociability under the given conditions As was to be expected, opinions varied The average ratings were as follows:

Item rating	Mean rating for item	Item rating	Mean rating for item
1	—1 0	13	—0 8
2	—1 0	14	0 0
3	0 0	15	—1 2
4	+1 0	16	—1 4
5	—1 4	17	—1 0
6	—2 0	18	—0 4
7	—1 8	19	—1 4
8	—1 6	20	—1 0
9	—1 6	21	—1 4
10	—1 4	22	—1 6
11	—1 0	23	—1 4
12	—0 2	24	—1 6
		25	—1 2

By combining all the behavior items averaging a rating of +1 or more and also all those rated as —1 or less, it was possible to determine the average frequency per pair for behavior most conducive to sociability and least conducive to sociability (Table 3)

While the children played with clay there was more behavior of the type judged conducive to sociability than while they played with blocks Likewise, the behavior least conducive to sociability was observed more frequently with blocks as material. The differences are not entirely statistically significant but the chances for their being true differences are high

TABLE 3

COMPARISON OF CLAY AND BLOCKS FROM THE AVERAGE PER PAIR OF FREQUENCY OF ALL ITEMS LISTED AS MOST CONDUCIVE AND LEAST CONDUCIVE TO SOCIABILITY AND COOPERATIVENESS

	Clay			Blocks				
	Total frequency per pair	Mean	Standard deviation	Total frequency per pair	Mean	Standard deviation	Standard deviation of difference	Ratio of difference to standard deviation of difference
			Most conducive to sociability					
Group I	703	25 11	9 71	600	21 43	7 99	2 42	1 56
Group II	1170	34 41	7 36	993	29 21	8.25	1 90	2 74
			Least conducive to sociability					
Group I	187	6 68	4 99	242	8 64	5 27	1 39	1 41
Group II	102	3 00	2 02	148	4 35	3 39	67	2 02
			Most conducive to cooperativeness					
Group I	224	8 00	4 62	180	6 43	3 78	1 15	1 37
Group II	397	11 68	3 67	345	10 15	3 99	93	1 65
			Least conducive to cooperativeness					
Group I	208	7 43	5 65	261	9 32	5 94	1 58	1 20
Group II	148	4 35	5 79	111	3 26	2 58	1 09	1 00

Cooperativeness was defined as that quality in an individual which makes him willing to carry out activities with others without submerging his own individuality As in the determination of traits of sociability, the same five staff members listed the behavior items that represented examples of cooperativeness between two children. By tabulating the total frequencies for those items listed by at least three raters as indicating cooperative behavior (Table 3), it was possible to determine whether one play material had greater influence on this type of behavior than the other The results indicate that there was a general tendency for behavior of a more cooperative kind to occur while the children were playing with clay (Items 5, 6, 7, 8, 10, 12, 21, 22, 23) Supporting the same conclusion is the fact that the least cooperative behavior, occurrences of behavior items listed by none of the five raters as being cooperative (Items 1, 2, 9, 14, 19, 20), was observed more often with blocks than with clay.

From these comparisons it may be concluded that the difference between clay and blocks in furthering those types of behavior which may be considered most conducive to sociability and cooperativeness is in the favor of clay

Chronological Age as a Factor Influencing Social Behavior In order to determine to what extent the behavior of the two-year-old children varied from that observable in the three-year-old, the frequencies of occurrence of the items of behavior were compared for the two age groups for each material In Table 4 are listed those items which differentiated the two groups With both materials the younger children paid less attention to their partners than did the older children, as indicated by Item 2 The older children were subjectively observed to be more conscious of their partners, they seemed to share each other's interests for longer periods. Observations for both materials showed that the three-year-olds made more verbal suggestions for new uses of the materials, made more counter suggestions, and held more conversation concerning the materials than was the case with the two-year-olds In addition, when clay was the material used, the three-year-olds exceeded the two-year-olds in the number of suggestions for mutual activity and in attempts at compliance with the suggestions of the partners.

A combination of Items 5, 6, 7, and 8 to compare verbal suggestions made with the two materials makes clear the fact that the three-year-olds were evidently much more liable to tell their partners what to do. Therefore, the relative percentage of positive and negative responses for each age was computed with the following out-

TABLE 4

ITEMS OF BEHAVIOR FOR WHICH FREQUENCY VARIED WITH CHRONOLOGICAL AGE

Item	Group I Frequency	Group I Mean	Group I Standard deviation	Group II Frequency	Group II Mean	Group II Standard deviation	Ratio of difference to standard deviation of difference
Clay							
2	100	3.57	3.77	32	94	1.23	3.55
5	86	3.07	2.25	150	4.41	3.13	2.39
7	6	.21	55	27	79	93	2.76
10	55	1.96	1.61	104	3.06	1.64	2.68
12	18	64	85	52	1.53	1.19	3.42
15	144	5.14	4.48	421	12.38	4.34	6.41
23*a*	27	96	98	15	44	60	2.48
5, 6, 7, 8	110	3.93	2.37	197	5.79	2.02	3.21
Blocks							
2	112	4.00	4.09	63	1.85	3.37	2.24
5	55	1.96	1.12	127	3.73	1.58	5.21
12	9	32	66	59	1.73	1.36	5.42
15	161	5.75	4.98	401	11.79	5.11	4.68
5, 6, 7, 8	88	3.14	2.06	184	5.41	2.29	4.02

TABLE 5

Comparison between Group I and Group II of the Average per Pair of Frequency for Each Material of All Items Listed as Most Conducive and Least Conducive to Sociability and Cooperativeness

	Group I			Group II				
	Total frequency per pair	Mean	Standard deviation	Total frequency per pair	Mean	Standard deviation	Standard deviation of difference	Ratio of difference to standard deviation of difference
				Most conducive to sociability				
Clay	703	25.11	9.71	1170	34.41	7.36	2.26	4.12
Blocks	600	21.43	7.99	993	29.21	8.25	2.09	3.72
				Least conducive to sociability				
Clay	187	6.68	4.99	102	3.00	2.02	1.02	3.61
Blocks	242	8.64	5.27	148	4.35	3.39	1.16	3.70
				Most conducive to cooperativeness				
Clay	224	8.00	4.62	397	11.68	3.67	1.09	3.38
Blocks	180	6.43	3.78	345	10.15	3.99	1.00	3.72
				Least conducive to cooperativeness				
Clay	208	7.43	5.65	148	4.35	5.79	1.48	2.08
Blocks	261	9.32	5.94	111	3.26	2.58	1.22	4.97

come: with clay, the three-year-olds responded positively to 78% of the suggestions, the two-year-olds to 65%, with blocks, the corresponding proportions were 70% and 55%. These are significant differences for both age groups (4, pp 248-250).

The three-year-old children were more cooperative and more sociable than the two-year-olds (Table 5).

Adequacy of Sampling

Questions arise concerning the degree to which these results might have been different if the children had been paired oftener, and whether a small number of pairings would have been as satisfactory.

The latter question might be answered empirically by the fact that decreasing the number of pairs from 28 and 34 to 14 and 17 reduces the value of the statistical procedures which may be utilized To meet the problem differently, half of the data, the results of only two pairings of each child, once with a boy and once with a girl, was treated by the same method as the results of all four pairings as so far discussed in this article.

Upon scanning the means and variabilities of the frequencies for each item, the results from two and four pairs seemed much alike. To check further, the four distributions, one for each age for each material, of the mean frequencies of each of the 25 items computed on the basis of two pairs were correlated by the rank-difference method with means computed from four pairs The resulting *r*'s were .96, .91, 96, and .94. From the standpoint of relative frequency of occurrence of the separate items, then, the data from the two pairs were like those from four.

The differences found were certain to be less accurate and significant with the two pairs, due to the small number of cases When significant differences of frequencies with age and material were analyzed item by item for the two and four pairs, the results seemed comparable For the combined items, however, the reliabilities of the differences were greatly reduced when data from only two pairs were used

It is possible that only two pairings of a larger number of children would be quite satisfactory. Evidently four pairs were sufficient, judging by the high correlations of two and four pairs.

Comparison With Other Studies

The results of this work are not in entire agreement with those of other investigators Possibly the differences are due to emphasis on different phases of social behavior Hulson (3), using size of

group as criterion of social value, felt clay to be of much less value than blocks, Van Alstyne (5), having other criteria, found clay low in "active cooperation." That the present study found clay to encourage a group of traits conducive to sociability and cooperation is perhaps due to a more qualitative and detailed analysis of social behavior manifested under these conditions. It is true, however, that in this study blocks were found to contribute to mutual activity with the material more than did clay, and this fact is in agreement with the findings of others According to Van Alstyne, blocks are of high value as compared to all materials, and above all to clay in encouraging conversation. This study showed little difference between the total amount of conversation with the two materials Van Alstyne indicated that cooperation and conversation increased with age; this correlates with these findings.

Summary

This study was directed toward the observation, under experimental conditions, of the types of social behavior stimulated in two- and three-year-old children by two play materials, clay and blocks. The data were taken from observations of 28 children, each paired eight times with one other child playing in a room where only one kind of play material, either clay or blocks, was available. Comparisons were made on the basis of mean frequency per pair of the occurrence of each of 25 specific behavior items checked during the observation period.

During the experimental periods certain types of behavior were common; the children spent much time near each other, watching each other, and talking with each other concerning the material with which they were playing. When the two-year-olds and the three-year-olds played with clay, they watched the play behavior of each other far more than when they played with blocks For both groups, blocks seemed to encourage more mutual activity with the use of the material but less without its use Partner's suggestions were less often accepted with blocks than with clay Clay encouraged more imitation

Sociable and cooperative behavior, determined after a judgment by raters of the value of the separate items for encouraging and discouraging these characteristics, was found to be differently stimulated by the two materials. Behavior of a sociable and cooperative type occurred more frequently during play with clay, while non-sociable and non-cooperative behavior had a higher frequency during play with blocks

There were several decided age differences The two-year-old children paid less attention to their partners than did the three-year-olds. The older children made more verbal suggestions to their partners, accepted more suggestions positively, held more conversation with them, were more sociable, and were more cooperative.

References

1 Bridges, K M B Occupational interests of three-year-old children *Ped Sem & J Genet Psychol*, 1927, 34, 415-423.

2 Garrison, C Permanent play materials for young children New York. Scribner's, 1926 Pp xxii+122.

3 Hulson, E L An analysis of the free play of ten four-year-old children through consecutive observations *J Juv. Res*, 1930, 14, 188-208

4 Holzinger, K J Statistical methods for students in education New York Ginn, 1928 Pp. viii+372

5 Van Alstyne, D. Play behavior and choice of materials of preschool children Chicago Univ Chicago Press, 1932 Pp xii+104

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UNE ÉTUDE EXPÉRIMENTALE DU COMPORTEMENT SOCIAL STIMULÉ CHEZ LES JEUNES ENFANTS PAR CERTAINS ARTICLES DE JEU

(Résumé)

Les personnes qui connaissent le jeu collectif des jeunes enfants ont fréquemment dit que certains articles de jeu sont de plus de valeur que d'autres pour encourager le jeu sociable Ces observations ont pour la plupart manqué d'épreuves. Cette étude a été faite dans le but d'observer dans des conditions expérimentales certains aspects du comportement social qui se montrent pendant le jeu limité à un article On a obtenu les données des observations contrôlées de vingt-huit enfants, âgés de deux et de trois ans, chacun mis en paire huit fois avec un autre enfant jouant dans une salle où seulement une sorte d'article de jeu, argile ou cubes, a été fourni

L'argile a encouragé les enfants à se regarder plus que les cubes, et aussi a stimulé plus d'imitation Les cubes ont semblé encourager plus d'activité mutuelle avec l'article donné, mais moins sans lui Le comportement sociable et le comportement coopératif, jugés d'après une sommation de diverses formes de comportement, se sont montrés différemment stimulés par les deux articles. Le comportement d'un type sociable et coopératif s'est montré plus fréquemment pendant le jeu avec l'argile, tandis que le comportement non sociable et non coopératif a été plus fréquent pendant le jeu avec les cubes

Il y a eu plusieurs différences d'âge Les *enfants âgés de deux ans ont* fait moins d'attention à leurs camarades que ceux de trois ans Les enfants les plus âges ont fait plus de suggestions verbales, ont accepté plus de suggestions positivement, ont été plus sociables et plus cooperatifs

UPDEGRAFF ET HERBST

EINE EXPERIMENTELLE UNTERSUCHUNG DER BEI JUNGEN *KINDERN DURCH GEWISSE SPIELSTOFFE ANGEREGTEN* SOZIALEN TATIGKEIT

(Referat)

Personen, denen das Gruppenspiel junger Kinder bekannt ist, haben oft behauptet, dass gewisse Spielstoffe fur die Anregung zu sozialem Spiel wertvoller seien, als andere Solche Behauptungen sind grossenteils ohne Unterstutzung geblieben In der gegenwartigen Untersuchung wurde der Versuch gemacht, unter experimentellen Bedingungen gewisse Seiten der bei dem auf einen einzelnen Spielstoff beschrankten Spiel stattfindenden sozialen Tatigkeit [social behavior] zu beobachten Die Befunde wurden an kontrollierten Beobachtungen an 28 zwei- und drei-Jahr-alten Kindern erobert Jedes Kind wurde acht Mal mit einem anderen Kinde gepaart, welches in einem Zimmer spielte, worin nur eine Art Spielstoff—entweder Lehm order *Bausteine—den Kindern zur Verfugung stand*

Der Lehm regte die Kinder mehr dazu an, einander zu beobachten, als es die Bausteine taten, und der Lehm regte auch mehr zur Hachahmung an. Die Bausteine schienen *mit* dem gegebenen Spielstoff *mehr* zu einer gegenseitigen Beschaftigung anzuspornen, aber *ohne* den Spielstoff *weniger* Soziale Tatigkeit und kooperative Tatigkeit, auf Basis der Summierung *verschiedener Tatigkeitsgestalten [behavior patterns] erwagt*, erwiesen sich als durch die zwei Spielstoffe auf verschiedene Weise angespornt. Tatigkeit sozialer und kooperativer Art fand wahrend des Spielens mit Lehm haufiger statt, wahrend nicht-soziale und nicht-kooperative Tatigkeit wahrend des Spielens mit Bausteinen eine hohere Frequenz offenbarte

Es zeigten sich mehrere Altersunterschiede. Die zwei-Jahre-alten Kinder schenkten ihren Spielgefahrten weniger Aufmerksamkeit als die drei-Jahrealten Die alteren Kinder machten haufiger Vorschlage, nahmen mehr Vorschlage auf positive Weise an, unterhielten sich haufiger [conversed], und verhielten sich sozialer und kooperativer

UPDEGRAFF UND HERBST

AN ANALYSIS OF THE SPONTANEOUS RESPONSES OF THE NEWBORN INFANT*[1]

From the Psychological Laboratory of the University of Virginia

BEVERLY VON HALLER GILMER

INTRODUCTION

A survey of the literature regarding the behavior of the newborn infant (6) reveals that although there have been many studies seldom have these reports contained descriptions which would make it possible to compare the responses of the newborn with those of other subjects The responses have been named but not described. In the absence of such description some writers have gone so far as to doubt whether the responses of the newborn are in any sense organized or patterned The present study is connected with a detailed analysis of the spontaneous responses of the newborn, defining spontaneous responses as those responses which occur without stimulation by the experimenter.

The study is divided into two parts. In the first part a set of cinematographic data were analyzed and a tentative classification and analysis of the responses arrived at It was not practicable, however, to obtain a large quantity of moving-picture records Consequently, in the second part the tentative analysis was checked against a large number of direct observations in order to test its general applicability

SURVEY OF THE LITERATURE

As stated above, a search into the literature reveals little actual description of the spontaneous responses of normal newborn infants. This brief review includes all the descriptions found

Yawning Blanton (1) witnessed one subject yawning at five

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hours, with eyes tightly closed. Another subject's eyes were squeezed tight, and her chin trembled as she shut her mouth. Still another yawned so slightly that the yawn was hard to distinguish from a sigh

Crying Blanton (1) reports that the subject in crying pulls down the inner corners of the brows, making wrinkles The square, box-shaped mouth is noted also Preyer (12) notes drawing down of the corners of the mouth and wrinkling of the forehead Irwin (9) states that kicking occurs during crying Irwin and Weiss (11) regard crying as a component of mass activity

Sneezing Champneys (3) says. "Sneezing was always accompanied by violent movement of all the limbs, the thighs being flexed on the abdomen, the forearms bent, and the elbows thrust forward"

Sucking. Escherich (8) says that sucking consists chiefly of a downward movement of the lower jaw, with the tongue movement secondary to this Blanton (1) describes sucking as consisting of the tongue protruding from the mouth with the edges curled upward and over in such a way as to make the partial vacuum essential to sucking

Stretching. Buhler (2) says that in stretching the head is bent dorsally, hands are extended above the head, and the legs are extended Blanton (1) has described stretching as a movement varying from a mere full raising of the arms and a complete stretching of the legs and toes, to arching of the back and abdomen and pushing of the arms until they tremble, accompanied by the bending of the ends of the fingers. In one case she notes a movement of the neck and pulling forward of the shoulders.

PART I

Subjects. Four white subjects were used in this experiment, ranging in age from the first day through the tenth day. All the infants were born in the University Hospital and, according to hospital charts, all subjects were normal and in good health. Additional data on each subject are as follows:

Toms, female, birth wt. 4000 gms, third child of 23-year-old mother. Studied from fifth through ninth day.

Welcher, male, birth wt 3260 gms, third child of 27-year-old mother Studied from seventh through ninth day

Dameron, female, birth wt 3500 gms, third child of 36-year-old mother. Studied from first through tenth day

Street, female, birth wt 2725 gms, first child of 18-year-old mother Studied from first through eighth day

Method of Securing Records. The infants were studied in the nursery of the University Hospital. They were photographed in their steel cribs (approximately 14" x 28" x 10") which were fastened to the wall so that the tops of them were 4 feet from the floor. Upon the crib was placed the four legs of a specially constructed wooden camera holder This put the Cine Kodak Camera (Model B K A, f 1 9 lens, 100-ft film capacity, 16 exposures per sec) in a position 5 feet above the baby

Floodlighting was obtained by the use of a double Kodalite (Model B, containing two 500-w., 115-v Mazda lamps) which was thrown against the wall directly above the crib It was found in the preliminary photographing that to insure uniform running and timing of the camera it was necessary to remove the camera from the holder and rewind after approximately 30 seconds of running Timing was done by means of a stop-watch

All pictures were taken between eight and nine o'clock in the morning, immediately after bathing and before feeding at 9 15 A M

Two infants were available for study each morning, and they were photographed alternately One experimenter (Dr. Dennis) operated the camera and one (Gilmer) recorded the name of the baby, its condition, and the nature of the reaction An attempt was made to photograph all the spontaneous movements of the infant which was under the camera. *The camera was started at the beginning of each response,* unless the camera-man was obviously too late, and was not stopped until the response had ended Sixteen hundred feet of Cine-Kodak Panchromatic Safety film were used

Method of Analysis The apparatus used in studying the film was a hand-cranked Vitascope Movie Maker (burning a 100-w, 115-v Mazda projection lamp) Pictures were projected against a white wall The projector was so arranged that the pictures could be run backward as well as forward. Speed of movement could be made to vary from around 32 exposures per sec. to a stilling of the individual frames

After a great deal of preliminary study of the records we felt that we had arrived at an adequate classification Each response was numbered and named. Then, by repeated showing of each response, the constituent elements were determined and the basis of classification was thus arrived at After this analysis had been made,

the experimenter reclassified and reanalyzed several responses without knowledge of the reel and picture presented (pictures selected by Dr. Dennis) A confirmation of the original classification and analysis was made in all cases

Definition of Descriptive Terms Used. The results of the cinema analysis are presented in Table 1. Before discussing this it is necessary to define some of the terms used. Only those terms which are not commonly employed will be defined

Corners of the mouth retracted. Here we have the corners pulled towards the ears.

Mouth horizontal In this paper the ear-to-ear direction will be called horizontal and the forehead to chin direction will be called vertical. We use the term "mouth horizontal" to describe a mouth opening in which the corners are retracted, that is, separated farther than in their resting position.

Mouth vertical. Here we find the corners are not retracted but that the movement consists wholly in vertical opening The degree of opening is variable.

Tongue "flat" and protruding. The tongue comes forward in varying degrees, flat from side to side although sometimes arched in the dorso-ventral direction

Tongue "trough" and protruding In this position the tongue is the same as above save that the outer edges of the tongue are turned upward and over, forming a rounded trough

Naso-labial fold Term used in describing the lines running from the corners of the nose to the corners of the mouth.

Naso-labial fold extending to the chin Here the line extends beyond the corners of the mouth to a distance of approximately half way down the chin

Wrinkled at the bridge of the nose. Here we have a line across the nose connecting the inner corners of the two eyes.

Shortened nose. The end of the nose is pulled upward toward the forehead

Chin drawn in to neck The head is pulled slightly downward until the chin rests lightly against the neck This is always accompanied by the skin on the chin being wrinkled in furrowed horizontal lines or in the "dried peach" shape.

Results It was found possible to classify the responses into distinct classes Each of these classes was then analyzed in detail to discover its elements The results of this analysis are given in Table

1 In compiling this table two or more identical reactions (such as cries) which occurred without intervening reactions were treated as one unit in the tabulation This latter procedure was adopted as a conservative measure because such consistency of response pattern in temporally contiguous responses might misrepresent the consistency of the responses in general.

It was found in the analysis that the data from each individual subject were so well in agreement with the data of each other subject that the responses could be grouped The total number of units represented in Table 1 are as follows 34 cries, 25 mouthings, 23 stretches, 22 yawns, 20 openings of the mouth, 12 chewings, 10 suckings, 8 smiles, and 7 sneezes; total, 161 Other responses not included in the table will be discussed later

Table 1 shows in brief the comparative analyses of these reactions Each type of response is listed at the top of the table, with the exception of those few responses to be discussed later The percentage of occurrence of each response element is given in the table Study of the table will show in regard to each type of response which elements were essential (always present), which were incompatible (never present), which were unessential (sometimes present), and which were peculiar to that reaction (never present as an element of another reaction)

We shall summarize briefly our findings in regard to each response. The summaries below include the data of Table 1 and also additional data which could not readily be presented in the table

Tentative Analysis of the Reactions

Crying. In crying, the mouth is always opened in some horizontal fashion ranging from slightly horizontal through the extreme horizontal position in which the mouth takes on the four-cornered box-shape. The naso-labial fold is always present At the beginning of any crying period the eyes may be in an open, half-open, or a normally closed position They eyes are, however, always closed tightly by the time the height of the cry is reached. (The observational study of Part II shows that this is an incorrect generalization) When the eyes are tightly closed wrinkles are always found under them, together with a pulling down of the nasal end of the brow In crying, we find present in every instance the line connecting the inner corners of the eyes across the bridge of the nose We find also that the chin is always pulled toward the neck enough to produce the furrowed wrinkles, although in varying degrees.

TABLE 1

PERCENTAGE OF TOTAL RESPONSES OF EACH TYPE CONTAINING RESPONSE ELEMENT

	Crying	Stretching	Sneezing	Mouthing	Yawning	Opening mouth	Chewing	Sucking	Smiling
Asleep	6	96	43		32			30	100
Awake and quiet	56	4	43	100	68	100	100	70	
Awake and restless	34		14						
Corners of mouth retracted			30					100	100
Mouth closed		100	14				8		100
Mouth horizontal	100		72	100		100	92		
Mouth vertical			14		100				
Lips rounded and protruded								100	
Tongue "flat" and protruding				88					
Tongue "trough" and protruding				12				100	
Eyes open				8		20			
Eyes half open				72		45		80	
Eyes closed normally		9		20	9	35	42	20	100
Eyes closed tightly	100	91	100		91		58		
Naso-labial fold	100	91	70		100	10	100	100	
Naso-labial fold ext to chin			50						100
Wrinkled at bridge of nose	100								
Shortened nose					100				

TABLE 1 (*continued*)

	Crying	Stretching	Sneezing	Mouthing	Yawning	Opening mouth	Chewing	Sucking	Smiling
Chin drawn in to neck	100					5	100	100	100
One or both arms relaxed				68	73	65	92	90	100
One or both arms tense	23				27				
One or both arms moved up or down	68			8		20	8		
One or both arms *moved in or out*				24		15		10	
One or both arms extended above the head	9	9							
Forearms drawn toward head and shoulders		91							
Forearms jerked slightly up and in toward head			100						
One or both legs relaxed				68	82	65	92	100	100
One or both legs tense	15				18				
One or both legs extended				20		15	8		
One or both legs flexed	17	100	100	12		20			
One or both legs kicking	68								

Limb movement is not always present, but when it is the movements of the hands and feet are in a plane parallel to the median plane of the body. The amount of limb movement varies with the intensity of the cry Every intense cry produces much arm and leg movement In this degree the arms are worked rapidly up and down while the legs are kicking violently. When the arms and legs are not moved in crying they are always held tense. Although not shown by the table, the analysis shows that crying has a slow termination as opposed to a rapid ending found in some other reactions.

What may be termed a "cry face" was noticed several times but not put into the table. Here we have all the facial features of a cry save that the mouth is not opened The corners of the mouth are drawn slightly inward and downward. Limb movement is practically nil. This "cry face" appears to be the slightest degree of crying.

Only in crying do we find the mouth in a four-cornered box-shape, and the face wrinkled at the bridge of the nose These elements never occur in isolation nor in any other spontaneous reactions save crying

Stretching. In stretching we find the mouth always closed, and in the majority of cases the eyes are closed tightly The naso-labial fold is found present only in those cases in which the eyes are closed tightly In the larger number of cases the forearms are drawn in toward the head and shoulders with the upward pull being at the shoulders rather than in the forearms. In the remaining cases the arms are straightened out above the head. These responses are peculiar to stretching. Contrary to Buhler's statement, the legs are always flexed (Dr. Dennis reports that he saw leg extension in stretching in one of four premature infants studied by him) In a number of cases we find the subject rearing up on the back of the head and arching the back This seems to occur in the more extreme stretches The termination of a stretch is somewhat drawn out Stretching always occurs in a sleeping or quiet and awake state, never breaking in upon a cry

Sneezing In the sneeze we do not find any stereotyped opening of the mouth; it may close or it may open horizontally The eyes are always closed tightly on the inspiration and remain so until the expiration The naso-labial fold is present in each case and extends to the chin in some of them

In strong sneezes, the forearms are jerked slightly upward and

inward and the legs are flexed in each instance at the moment of expiration. Slight sneezes are observed in which there are no arm and leg movements, but there are never movements of any other kind than those just described These movements are peculiar to sneezing The sneeze terminates immediately after expiration

Mouthing The feature that distinguishes "mouthing" from "opening the mouth" is the protrusion of the tongue from the mouth against or across the lower lip The mouth is always open in a horizontal position although in varying degrees Degree of opening the eyes varies. In two cases it was noted that one eye remained half open while the other one closed lightly In the majority of the cases the limbs are relaxed, never are they held tense. In those cases in which arm or leg movement is reported we find this movement to be very slight and apparently of little force. In every case of mouthing, the infant is awake and relatively quiet

Yawning Yawning is the only reaction in which we find a vertical opening of the mouth The naso-labial fold is always present and approaches a vertical position. The nose is always shortened. There is practically no movement with the arms and legs, the subject in most cases being relaxed. In general, it can be said that the yawn terminates immediately after its peak is reached Yawns occur while the subject is either in a sleeping or awake and quiet state

Opening mouth. This response differs from the yawn in that in this case the mouth never opens vertically (this is obviously not true of older children). The mouth may open horizontally in varying degrees The naso-labial fold is present when the mouth is opened widely. In some cases the eyes are closed normally and in the others opened to different degrees.

Where limb movement does not occur the limbs are always in a relaxed posture rather than tense When the extremities do move they may go in any direction but with very little force, these movements are not recorded on the chart The reaction always starts when the baby is in an awake and quiet state

Chewing Chewing is distinguished from the other mouth reactions by an up-and-down movement of the lower jaw, with no accompanying tongue play or lip reaction as found in sucking. The mouth is opened horizontally in varying degrees in 11 of the cases In the other case the mouth is entirely closed The eyes are always closed though sometimes normally and sometimes tightly Both the naso-labial fold and the drawn chin are present in each instance

Sucking The essential features in spontaneous sucking are the tongue protruding beyond the lips in the "trough" shape, and the rhythmic motion of the lower jaw The corners of the mouth are always retracted as the lips become rounded and protruded The naso-labial fold is always present The chin is always drawn in to the neck and in one case forms wrinkles in the "dried peach" shape, in the others forms the furrowed lines The eyes are either half open or closed normally The limbs are usually in a relaxed state Only in one case do we find slight movement

Smiling The essential and peculiar factor in the smile is the retraction of the corners of the mouth, together with an upward pull of the corners. We find each of the eight cases recorded perfectly stereotyped in that the corners of the mouth are always retracted, mouth closed, eyes closed normally, naso-labial fold extended to the chin, chin drawn in to neck, all limbs relaxed, and occurring in the sleeping state. (The observational study shows that the infant may be awake and the mouth open during a smile)

Other reactions In addition to the above patterned or organized reactions, we find certain isolated limb movements. The movement of an arm or leg may be in any possible direction, but it is to be noted that such a movement is never as vigorous as those movements wherein the total organism is brought into play. Rubbing the face was noted frequently Vomiting and hiccoughing were observed Frowning, and wrinkling of the forehead in horizontal furrows, were observed to occur Because of their relative simplicity these reactions were not added to an already-cumbersome table

These above reactions recorded in this section are *all* the responses observed, both those occurring in large patterns, and those occurring in relative isolation By no means has the above classification been "selective" All behavior which occurred has been included.

Part II

The cinematographic study resulted in tentative descriptions which could not be entirely relied upon because of the small number of responses which were studied While we did not believe that newborn responses could be completely analyzed as they occur in the nursery, we did believe that any common deviation from the descriptions arrived at above would be obvious upon protracted direct observation Consequently, we observed a large number of sponta-

neous responses as they occurred in the nursery and noted whether each, in so far as it could be observed, did or did not conform to the tentative description. Observations were made between 8 and 9 A.M. as in Part I A total of 16 babies were observed

All infants studied were normal white babies under ten days of age. The responses were classified as follows. 185 cries, 120 stretches, 44 sneezes, 120 mouthings, 80 yawns, 85 openings of the mouth, 60 chewings, 60 suckings, and 45 smiles. Since detailed analysis of rubbing the face, vomiting, and other reactions were not made in the study of Part I, they are not tabulated here. However, each such response was critically observed for elements believed to be peculiar to the analyzed responses We saw no new responses, and none which could not be fitted into the classification earlier arrived at

The results of the observational study may be put very briefly. The observational data conflicted with the earlier data on only two points. These have been mentioned parenthetically in the tentative descriptions but will be repeated here

1 *Crying*: In crying the eyes are not always closed. In addition the chin was seen to quiver in a few instances.

2. *Smiling* Seven smiles were seen in which the mouth was slightly open These occurred while the infant was awake and quiet

The direct observations thus provided almost complete corroboration of the movie analysis.

Summary and Discussion

This study has shown that it is possible to separate the unselected spontaneous responses of the newborn infant into distinct classes. This in itself seems to show that the responses show organization Further analysis has revealed the detailed characteristics of each class of response. The descriptions arrived at by this analysis are too long to be repeated here, but reference to them will show that each response has a characteristic combination of essential elements and nearly every response has some element peculiar to it. Of the non-essential behavior elements, some do and some do not appear in conjunction with each response If "pattern" and "organization" mean anything, they mean just those things outlined above

It is interesting to note further that spontaneous responses of the newborn may be divided into two groups with respect to the rôle of the limbs in the responses Reference to the behavior descriptions

will show that in intense crying, sneezing, and stretching, the legs and arms are vigorously involved, the mode of involvement being peculiar to each response In the case of the facial responses, on the other hand, the limbs are never vigorously involved. The legs and arms are either totally inactive at the moment of facial response or else they are moving with slight force as in isolated limb movements Limb stretching, for instance, never occurs during mouthing, although there is no anatomical impossibility in this. These facts mean, in brief, that the newborn's behavior organization is body-wide, his responses are total bodily responses The body segments do not act in complete isolation. This is an interesting fact in connection with Coghill's theories (4, 5), in connection with Irwin's application of them to infants (9, 10), and in connection with Dennis' criticism of Irwin's application (7) Our study supports Dennis' claim that mass activity is not the only total bodily response of infants, but that, on the contrary, there are many total bodily responses

References

1 Blanton, M. G The behavior of the human infant during the first thirty days of life *Psychol Rev*, 1917, 24, 458-483.

2 Bühler, C The first year of life (Trans by P Greenberg and R Ripin) New York. Day, 1930 Pp 277

3 Champneys, F H Notes on an infant *Mind*, 1881, 6, 104-107.

4 Coghill, G E The early development of behavior in Amblystoma and in man *Arch Neur & Psychiat*, 1929, 21, 989-1009

5 ———— Anatomy and the problem of behavior New York. Macmillan, 1929 Pp. 113

6 Dennis, W A description and classification of the responses of the newborn infant *Psychol Bull.* (in press)

7 ————. The role of mass activity in the development of infant behavior. *Psychol Rev*, 1932, 39, 593-595

8 Escherich, T Ueber die Saugbewegung beim Neugeborenen *Münch. med Woch*, 1888, 35, 687-689.

9 Irwin, O C The amount and nature of activities of newborn infants under constant external stimulating conditions during the first ten days of life *Genet Psychol Monog*, 1930, 8 1-92

10 ———— The organismic hypothesis and differentiation of behavior II. The reflex arc concept. *Psychol Rev*, 1932, 39, 189-203

11. Irwin, O C, & Weiss, A P A note on mass activity in infants *J Genet Psychol.*, 1930, 38, 20-28

12 Preyer, W The senses and the will (Trans. by H W Brown) New York Appleton, 1888 Pp 346.

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UNE ANALYSE DES RÉPONSES SPONTANÉES DU NOUVEAU-NÉ

(Résumé)

Cette étude nous donne une analyse de toutes les réponses spontanées du nouveau-né L'experience se divise en deux parties. Dans la première partie on trouve les données obtenues d'une étude cinématographique De ces données on arrive à une classification et à une analyse expérimentales Pour tester la valeur de l'application de cette analyse expérimentale on se sert d'une deuxième méthode, celle de faire des observations directes Les donnees obtenues par les deux methodes différentes s'accordent en presque tous les détails. On a employé un nombre total de vingt sujets, âgés d'un jour à dix jours On a étudié ces enfants dans la chambre des enfants de l'Hôpital de l'Université L'analyse classifie les reactions ainsi celle de pleurer, celle de s'étendre, celle d'eternuer, celle de mouvoir la bouche, celle de bâiller, celle d'ouvrir la bouche, celle de mâcher, celle de sucer, et celle de sourire On analyse chacune de ces réactions en détail La Table I montre brièvement les analyses comparatives de ces réactions avec les éléments des réponses et le pourcentage des fois où ils se voient Cette étude a montré le fait qu'il est possible de séparer en classes distinctes les reponses spontanées non choisies du nouveau-né Chaque réponse montre une combinaison caractéristique d'élements essentiels et presque toutes les réponses ont un élement propre L'organisation du comportement du nouveau-né est de tout son corps, ses réponses sont des réponses totales du corps Ce fait est très intéressant à propos des théories de Coghill Cette étude soutient l'assertion que l'activité globale n'est pas la seule réponse totale du corps chez les nouveau-nés, mais qu'au contraire il existe plusieurs réponses totales du corps

GILMER

EINE ANALYSE DER SPONTANEN REAKTIONEN DES NEUGEBORENEN SAUGLINGS

(Referat)

Diese Untersuchung bietet uns eine Analyse aller spontanen Reaktionen des neugeborenen Sauglings Die Untersuchung ist in zwei Teile getrennt worden. Im ersten Teile haben wir die aus einer kinematographischen Untersuchung erhaltenen Befunde. Auf Basis dieser Befunde gelangen wir zu einer vorlaufigen Klassifizierung und Analyse. Um die allgemeine Anwendbarkeit dieser vorlaufigen Analyze zu prufen hat man eine zweite Methode—die Methode der direkten Beobachtungen—angewendet Die mit den zwei verschiedenen Methoden erhaltenen Befunde stimmen in fast jeder Einzelheit mit einander überein Es dienten im Ganzen 20 Versuchspersonen, deren Alter sich zwischen einem Tag und 10 Tagen erstreckte Die Sauglinge wurden in der Kinderstube des University Hospital untersucht Durch die Analyse wurden die Reaktionen folgenderweise klassifiziert Schreien, Sich-Strecken, Niessen, Gesichterschneiden [mouthing], Gähnen, Mundoffen, Kauen, Saugen, und Lacheln Jede dieser Reaktionen wird ausfuhrlich analysiert Auf Tabelle I sieht man, kurz dargestellt, die vergleichenden Analysen dieser Reaktionen, samt den Bestandteilen der Reagierungen und dem Prozentsatz ihrer Haufigkeit In dieser Untersuchung ist erwiesen worden, dass es moglich ist, die unausgelesenen, spon-

tanen Reaktionen des neugeborenen Sauglings in einzelne Klassen zu teilen Bei jeder Reaktion findet man eine karakteristische Verbindung wesentlicher Elemente, und fast jede Reaktionsweise hat einen Bestandteil, der ihr eigen ist Die Organisation der Tatigkeit des Neugeborenen erstreckt sich uber den ganzen Korper [is body-wide], seine Reaktionen sind Gesamtreaktionen des ganzen Korpers Diese Tatsache ist in Bezug auf Coghill's Theorien von Interesse Durch diese Untersuchung wird die Behauptung unterstutzt, dass Massentatigkeit nicht die einzige korperliche Gesamtreaktion [total bodily response] bei Sauglingen ausmacht, sondern dass es im Gegenteil viele korperliche Gesamtreaktionen gibt

GILMER

MONOZYGOTIC DICHORIONIC TRIPLETS. PART II
BEHAVIOR OF A SET OF IDENTICAL TRIPLETS*

From the Samuel S Fels Fund for Research in Prenatal and Postnatal Environment

L W SONTAG AND V. L NELSON

Part I of this report of monozygotic triplets was published recently by the authors (2). The study contained a description of the physical and mental characteristics of the triplets, records of their growth and nutrition, analysis of their finger and palm prints, and a description of the fetal membranes. This material was presented primarily to establish the monozygotic origin of the triplets In addition, certain facts regarding the birth of the infants were included because it was felt that they might be of interest to medical readers. All of the observations were made by members of the staff of the Samuel S Fels Fund, an organization for the study of prenatal and early postnatal environment in children The Fels Fund is located at Antioch College, Yellow Springs, Ohio

The triplets, in addition to being of interest from the standpoint of physical comparison and of the conditions surrounding their birth, offered an excellent opportunity for research in the development of behavior differences Part II of this report contains, therefore, such a study, drawn from observations of the behavior of the triplets made at least once each month from the time they were 12 months old until they reached the age of 42 months The children are now 4 years old

It is obviously impossible to give here the complete records of the 150 hours of observation made on the triplets It would be objectionable to omit parts of the records which we do not consider of primary importance, or to present only those incidents which lend credence to the conclusions to which we have come We have contented ourselves with including in this discussion three mornings' observations which will serve as examples of the material from which our con-

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clusions have been drawn. In addition, we have described such environmental factors as were not common to all of the triplets

The observations have been made largely by the authors themselves However, two other members of the Fels Fund staff, one a physician and one a psychiatrist, have also observed the children.

Records of Observations of the Triplets

Throughout the records which follow, we shall identify the triplets as Fred, John, and Henry, in order of their size, and of their birth

In recording the behavior of the trio, two methods were used. One consisted of a detailed account of the activities and conversations of the children, the other of brief descriptions of their behavior The account immediately following illustrates the former method; the second and third records illustrate the latter method The description of habits is taken partially from statements by the mother.

Visit to Triplets, 4-23-32 8 A.M to 12 M

1 *Henry was in the front yard when VN, the Fels Fund investigator, arrived.* John and Fred were in the back yard where some men were fixing electric wires Henry greeted VN, "Hi! Where games?" picked up her suitcase and carried it to the house. The boys' mother reported that John's speech was much more distinct than that of his brothers VN received the same impression Henry pointed to the back of the house saying, "Men fix lights," and then went to the back yard. Fred and John stood watching the men. All three had been there earlier in the morning Henry climbed the fence and then went to where Fred and John were standing.

2 8.30 A M All three were at the front of the house at VN's request. There was no difference in their willingness to go Two *of the boys were given pencils and paper to make pictures* The mother, working in the house, heard VN talking to the boys and brought a pencil out and handed it to Henry, John and Fred already having pencils John reached over and handed his own pencil to Henry, who took it in exchange for the one their mother had handed to him John said as he did so, "That's my mother's good one I'll take it in the house" He went into the house and handed his mother the pencil, saying, "Here, mother" He came out immediately, saying, "I took it upstairs My mother had to put it away" The pictures were finished and given to VN

3 8:45 A.M. Everyone went to the back yard, Henry first, then John and Fred immediately after. John said to VN, "See bunnies," and all three talked about their bunnies in a cage in the back yard The three went to the sand pile near which the men were fixing a ladder. John said to VN, "We got a sand pile too." Then the three slid down a plank arranged as a slide, the order of going being Fred, John, Henry.

4. 8 55 A.M. Henry left the group, and began tinkering with a case knife about a wagon, turning it on its side and working at the rear wheel Fred came over and began to use the front wheel as a steering wheel A fight ensued, Henry and Fred squealing and pushing each other Henry said, "Go away, mine wagon" Fred gave up and left after a short struggle, going over and picking up a toy gun. As soon as Fred had gone, Henry also left the wagon, going over to watch the men

5 9:10 A.M Henry got down from the fence, went to the wagon and set it upright He said to VN, "Pull me! Pull me!" John appeared and both got in John said, "Take me around 'kar' (square)" Fred accepted VN's invitation to join the group and climbed in when the other boys moved over to make room for him. All three remained quiet during the trip around the square

6. 9 45 A.M Fred was on the tricycle, and Henry climbed on the back John was in the house A neighbor boy arrived with a small scooter He is about six months older than the triplets Henry got the wagon, and, going up to the boy, said, "Ride me!" The neighbor boy put the scooter in the wagon, and Henry climbed in behind John got in too, and Fred came over and pushed the wagon For some time the four boys played with the wagon, there was little disagreement

7 10:00 A.M Fred left the wagon first and went up the street several houses where a man was working with a hose The neighbor boy, pulling John and Henry, stooped to look at an insect. He put it in the water which was running down the gutter, after which he began to walk in the gutter Henry stepped in too, unseen by his mother, but soon got out John stayed in the wagon

8. 10 15 A.M. Henry again began walking in the water while John and Fred were up the street His mother saw him and cried, "You, Henry!" running toward him. Henry came toward her, whimpering, she jerked him to her and spanked him. She took

Henry upstairs and spanked him some more, after which she scolded him. She came down and reported that she had undressed him, put on his pajamas, and told him to stay in bed until his clothes dried He stayed there quietly for half an hour, during which time his mother called to him several times, "Don't go to sleep, Henry" She then said to VN, "This punishment won't do any good; we have tried all we know, but he'll do a thing again. We don't know what to do with him" Fred and John remained up the street during this episode.

9 Fred came to watch his mother who was scrubbing the front hall She told him to wait in the doorway until she put some papers down. Fred obeyed, but said, "I 'tep on carpet," meaning the living-room carpet which was about 5 or 6 feet away. When he was informed that it was too far for him, he remained in the doorway as told He asked for a glass of water, drank part of it, and then went to the edge of the porch His mother said, "Don't pour that out," and then repeated the admonition, whereupon Fred dumped it over the edge of the porch His mother scolded him, set him down on the floor, and went to get Henry She brought him down with her customary admonition to be a good boy Henry did not reply at first, but finally said in an uninterested and unconvinced tone, "I be a good boy" The same promise was extracted from Fred, who agreed more readily

10. 11 00 A.M Henry was on the tricycle with the neighbor boy riding behind him as John came on the sidewalk with the wagon Fred attempted to get the neighbor boy off by talking to him and pulling him In the struggle, Henry turned and patted the neighbor boy as if consoling him Fred persisted for some time and then left John came up and attempted the same procedure. Henry again patted the neighbor boy, pushing John. The mother says Henry always sides with the neighbor boy

11 11 20 A M. All three boys and the neighbor were in the neighbor boy's yard, three houses away Fred was on the tricycle and Henry had a toy gun An altercation was started with Fred by the neighbor This time Henry did not side with the neighbor, but hit him on the cheek with the gun and attempted to bite him. The boy went around the house, crying, to tell his mother VN's presence apparently saved Henry a scolding by the neighbor boy's mother

12. 11:30 A.M. At VN's request all three boys came back to their own yard with her. The father of the triplets drove up in an automobile Fred, John, and Henry all exclaimed, "There's my daddy," and went to him, asking about a bottle of cleaning fluid he had in his hand The father spoke to them in a pleasant, even tone and displayed the cleaning fluid by pouring some on the corner of the pavement. Fred got a trowel and began to play in the mud, Henry coming over and saying, "Me want shovel." Fred and John went in the house and Henry began to fill the hole at VN's request He put in three trowels-full and then dug it out again, but finally filled it up and patted it down He put the trowel in his pocket and went in the house. During the few minutes the father was in the house he talked to the boys, wiped all their noses, and kissed them goodbye. There was no noticeable difference in eagerness on the part of the children, nor evidence of special favor on his part.

Visit to Triplets, 2-26-32

13. LS, with an assistant who was not known to the children, arrived at 2:00 P.M. to repeat taking finger prints of the triplets They were greeted by Henry and Fred, John hanging back and clinging to his mother's skirts. Henry immediately demanded to know what was in the black bag carried by the assistant. He was told it contained material to take pictures of his fingers. He persisted in inquiring about the bag and demanded to see its contents, attempting to help open it and remove the materials. A table on which to work was set up and the materials were spread out on it Henry stood at the edge of the table with Fred just behind him Henry attempted to pick up the ink pad, and, when restrained from doing this, managed to disarrange the cards upon which the prints were to be taken. After a few minutes of this, Fred took heart and moved up to the edge of the table also

14. The children were invited to come and have their finger prints taken. Henry was too busy examining the materials to heed the call, and so Fred was persuaded to be the first. As soon as he was seated on the knee of the assistant, Henry came around to the other side of the table and attempted to put his fingers on the ink pad, which was being used to ink Fred's fingers He was so persistent in this that he had to be removed from the table by LS and held while Fred's prints were being taken. He was assured that he could be the next to have his pictures made

15. Fred cooperated rather well in making the finger prints. He did not cry and he was very willing to relax his fingers so that they could be properly inked and the prints made When he was finished, his hands were wiped to remove the free ink, and he was allowed to run about the room.

16 Henry immediately clamored to have his prints taken. He climbed up on the assistant's knee, and his prints were taken. He was unwilling, however, to relax his fingers and hands and insisted upon doing the prints without the help of the assistant This unwillingness to cooperate led to the spoiling of two cards before a satisfactory one was completed

17 When the assistant had finished making his prints, Henry was put down on the floor, and John was invited to have his prints taken John was unwilling and whimpered when his mother attempted to force him It took much persuasion and some bribery to induce him to sit on the assistant's knee Even then he continued to whimper He exhibited none of the insistence to make his own prints which Henry had shown As soon as his cooperation was secured, the prints were made without difficulty. Henry again had to be held during this procedure to prevent him from shaking the table and interfering with making John's prints As soon as John's prints were finished, John slipped down to the floor and disappeared into the kitchen. A few minutes later, his mother discovered him on a high stool in the kitchen laboriously washing the remaining ink stains from his fingers

18 After the prints of all three had been made, the cards were examined, and it was discovered that two or three of the prints were not entirely satisfactory, so it was decided to remake these bad prints Henry insisted upon being first, and it was only with great difficulty that his prints were again made, since he insisted upon pressing his own fingers on the ink pad and making his own imprint While his prints were being taken, Fred stood beside the table and occasionally laid his hands upon it, but did not materially interfere with the work. John again clung to his mother's skirts When Henry's prints were made, Fred submitted without complaint to having his prints made, and again he cooperated fairly well. Henry had to be restrained again from interfering with the process When Fred was finished, several minutes were necessary to persuade John to undergo the process again He finally consented and seemed somewhat less

afraid than during our first attempt Henry spoiled several prints by jiggling the table. Henry was finally persuaded to leave the table and went again to the black bag, which was on the floor. He attempted to open it, and, when he could not manage this, he climbed up on it and stood on it When John's prints were made, he again went to the kitchen, climbed up on the high stool, and washed off the ink stains which had been left after LS wiped his hands with a towel While John was washing his hands, Henry again attempted to open the black bag which was on the floor. He was again unsuccessful. Before leaving, LS gave each of the boys a blank finger-print card John remained at his mother's skirts, while Henry and Fred followed LS and the assistant to the door. Henry followed out onto the walk

Visit to Triplets, 9-15-31

19 LS stopped at the triplets' home to make arrangements for a visit to the Fels Research Institute The three children were playing in the yard. Henry was riding the tricycle, which he had just taken from Fred Henry got off and, followed by John, stepped across the alley to the neighbor's lawn about which was built a terrace of small stones. Henry picked up a small bucket and placed one of the stones in it. Fred and John joined him and all three of them filled the bucket with stones and dragged it across the lawn Upon seeing the stones, the mother immediately demanded that the boys replace them. Fred and John dutifully took hold of the bucket and began to drag it back Henry laughed, climbed on his tricycle and rode down the street, despite his mother's calls that he return and help his brothers replace the stones. John and Fred up to this time had lugged the stones to the place from which they had taken them, and here they laid them down, one by one. They did not replace them in the proper places in the terrace, but laid them on it As soon as they had carried the bucket back to their own yard, Henry rode back and joined them

Description of Behavior Differences

Differences in the children's behavior, of which the preceding records contain some examples, may best be noted if consideration is given to their habits, and to their behavior toward the following:

1. Parents
2. Strangers

3 Playmates
4. Each other
5 Objects

The habits of all three of the triplets are rather regular They have very few dislikes in the way of food, and eat what is placed before them without question The few foods which they do refuse are refused alike by all three The mother knows only one exception to their likeness of tastes, John being less fond of tomatoes All three handle their forks and spoons well, and have done so for nearly two years.

All three sleep a part of each afternoon, and they all sleep well at night They usually go to sleep without difficulty The mother says that they sometimes call for a drink or some other little attention immediately after retiring, and that Henry is much the most frequent and most insistent in such demands He sometimes insists that his father or mother come to bed with him

None of the three has been troubled with enuresis since the age of 18 months Henry was the last to conquer this habit, which he did about six weeks after his two brothers.

All three triplets developed, at about the age of 12 months, the habit of tickling their noses with the corner of a blanket while going to sleep They still persist in this, and when sleeping without cover in hot weather, they not infrequently take off their pajamas and use them for this purpose John and Fred have been thumb-suckers since early infancy, John being the worst in this respect Henry has never developed the habit

John is the only one of the three who cries readily

Parents The behavior of all three of the triplets toward their father is, as far as we have been able to observe, very similar Henry appears to command a little more of his father's time and attention by being more persistent in his demands and by managing to get into more mischief than do the other two Although the father is inclined to be rather a stern parent, all of the boys are unusually fond of him. His orders are more likely to be obeyed than are the mother's. He does not hesitate to punish any lack of obedience.

There is more difference in the behavior of the triplets toward their mother than toward their father This difference may be and quite probably does result from the fact that upon the mother lies the chief responsibility for their care She is in contact with them

for the entire day, whereas the father sees them for only a few minutes in the morning and not again until five o'clock in the afternoon.

The children's reactions to their mother's attempts to maintain discipline are not vastly different. Of the three, Henry is much more frequently in mischief than the other two, and is more incorrigible. While he usually responds to his mother's spankings by weeping, as do the other two, he is inclined to forget the incident sooner than does Fred or John. According to his mother's statement, he is punished at least twice as often as is either Fred or John, who apparently commit about an equal number of misdemeanors. John usually takes punishment more seriously than does either Henry or Fred. He is more likely to whimper when punished and remains influenced by the punishment for a longer time. The mother's usual methods of punishment are spanking the children or sending them to bed. Henry's mischievous attitude is very apparent. He will persist in his mischief up to the minute his mother takes him by the hand and administers punishment.

The mother reports that Henry sometimes resorts to temper tantrums, stamping his feet and screaming at the top of his voice. The occasion for such a demonstration is usually when the mother leaves the children at home with one of the neighbors, whom they know, while she goes out to shop. The scene occurs just at the time she is saying goodbye to the children. While John has on a few occasions resorted to temper tantrums, he more often only cries or whimpers a bit without a display of temper. Fred is usually calm during his mother's departure.

None of the three manifests unusual fear either of their mother or of their father. Henry's callousness to punishment leads us to believe that he fears his parents less than do the other two. John shows more of what might be called a sense of responsibility to his mother or a desire to please her. (See paragraphs 2, 17, 18.) Henry shows less of this quality than does either of the others. (See paragraph 19.)

The mother shows interest in keeping the children happily at play, and, while she does not actually play with them very much herself, she is constantly on the alert to help out in suggesting new playthings and new ways for the children to entertain themselves. One gathers the impression from the mother's statements and from her behavior toward the children that she takes great

pleasure in them and is very proud of them. At the same time she expects a good deal of misbehavior on their part and feels that she must be somewhat of a martyr to them.

A grandfather has from time to time lived with the family, but since the triplets' behavior toward him is very little different from their behavior toward the father, it will not be described here.

Strangers. Henry and Fred display less shyness and timidity in the presence of strangers than one ordinarily expects children to show. These two are usually quick to greet strangers and readily enter into conversation with them. (See paragraph 13.) When they have become accustomed to people outside their immediate family, all of the triplets are quite at ease. They are quick to associate former experiences with the visitors and frequently demand playthings, pencils and paper, etc., which have been offered them by these people on former occasions. There is little difference in the three in this respect. (See paragraph 1.) John, when in the presence of strangers, is much shyer than the other two, and clings closely to his mother. (See paragraphs 13, 18.) However, when John does become acquainted with people outside of the immediate family, he seems more inclined to converse with them and is more responsive to questions and to interest than are the other two. This trait, however, is not marked. None of the three is very much inclined to exceptional behavior in the presence of strangers. So far as we are able to ascertain from watching them when strangers enter their home, they do not often resort to unusual exhibitions to gain attention, nor are they particularly prone to interrupt the conversation of adults to gain recognition. Henry gives the impression of being a bit more inclined to bid for attention than do the other two. Aside from this slight difference in Henry, and John's shyness, there is little observable difference in the behavior which they ordinarily exhibit and that exhibited in the presence of strangers.

Playmates. The triplets are inclined to play a great deal more among themselves than they are with their neighbors. One would expect this to be true since they have no neighbors of exactly their age, and since the mother prefers to have them remain close around home. Henry seems to be a bit more inclined to seek companionship with the other children than do his brothers, and he sometimes takes the part of neighboring children in quarrels involving the three triplets with their playmates. (See paragraph 10.) However, this

is by no means always the case, as evidenced by paragraph 11 The triplets' failure to spend more time playing with their neighbors does not seem to be associated with any fear of other children or with inability to get along with other children. It seems to be more a matter of finding themselves a self-sufficient group. Upon two occasions they spent a day at the Antioch College Nursery School, and there they played without hesitation with many children of their own age Although Henry not infrequently takes sides with the neighbor children against his brothers, he more frequently quarrels with them than do John and Fred, which may be because he spends more time with them than do the other two The triplets are very much interested in a neighbor boy about 10 years old who stops in at their home at frequent intervals All three of them seem very fond of him and enjoy playing with him

Each Other The children are adept at amusing themselves They play for hours on end with their tricycle, shovels, and other playthings They do not quarrel excessively among themselves. When they do quarrel, Henry is involved in more instances than either Fred or John. Not only is this true, but he more frequently gains his point than does either of the others (See paragraph 4) Quarrels frequently result from Henry's attempt to take toys from his brothers, and, in the majority of instances, after an altercation, Henry emerges with the desired toy When such is the case, Fred is usually content to go about his business without resorting to his mother for assistance or consolation, whereas John more frequently cries and seeks his mother's sympathy Henry is usually the leader of any new enterprise. After the undertaking has been started, however, he is often the first to leave it (See paragraphs 4, 19) He displays this lack of persistence or lack of sustained interest in much of his behavior When either Fred or John assumes the leadership in a new enterprise, Henry not infrequently usurps the leadership in the project (See paragraph 12) This dominance on Henry's part is one of the reasons for his frequent punishment While the other two may be involved in the mischief, ordinarily Henry is the leader Recently all three of the triplets have developed the habit of reporting misbehavior of either of their brothers to their mother Although the mother does not reward them for this procedure, they seem to gain considerable delight from it John is particularly fond of carrying tales

Objects. Henry displays more curiosity regarding new objects than do either of the other two. He is usually the most difficult to control in a new situation because he undertakes to investigate things which are new and strange to him. During his visits to the Fels Research Institute, he had to be watched constantly because of his tendency to reach for bottles, climb up on tables, etc. He is much more resistant to commands to leave things alone than are his brothers. (See paragraphs 14, 17.) He is inclined to take playthings from his brothers and not infrequently, when all three of the triplets are given new toys, his are the first to be broken. When such is the case, he often appropriates those of his brothers.

Differences in Environment of the Triplets

In Part I of this paper (2), a comparison of the physical characteristics of the triplets and a description of the birth membranes establishes them, the authors feel, as definitely originating from a single ovum. We therefore feel justified in eliminating heredity as a factor in the behavior differences which we have described. As the children have been raised in the same home and have never been separated for more than a few hours, much of their environment is alike. They are, for the most part, in contact with the same people, and have had, with minor exceptions, the same food except during early infancy. Certain other factors, however, have not been the same for all three.

The first apparent difference in the treatment of the triplets began at the age of two weeks as a result of Henry's inability to tolerate the food formula upon which he had been placed five days after birth. The fact that he was the smallest at birth may have been responsible for this inability to retain his feedings, or it may be that he suffered more from the trauma of birth. The latter should not have been the case, however, since his smaller size and the fact that the two larger children had already passed through the birth canal should have protected him from injury. At any rate, his inability to retain food made him very slow to gain in weight. This condition caused much concern on the part of the parents and attending physician. At one time his malnutrition was such that neither the physician nor parents expected him to survive. During this period—from the time he was two weeks old until he had reached the age of eight months—he was given a great deal more than his normal share of the parents' atten-

tion. He cried a great deal and, because of the anxiety of his parents, he was usually taken from his crib to be quieted. His sleep was frequently broken by these crying spells and, because of this, his mother remained ever on the alert to hear his wails and to quiet him. His mother usually held him during feeding in the hope that the upright position might make it possible for him to retain the feeding mixture. Fred and John, who were healthy and gaining satisfactorily, were forced to be content with less of their parents' attention than they might normally have had because of the unusual demands of Henry. Henry was not punished during these first months no matter how much he cried, whereas Fred and John both had already come under the disciplinary measures of their parents

Because of all this solicitation on the part of the parents, Henry had become, at the age of eight months, what is commonly called a spoiled baby At this time he began to tolerate his food satisfactorily and to gain weight rapidly. With improvement in his physical condition, his parents' anxiety subsided, and the attention of the household, which had been so easily gained by any manifestation of distress on his part, was no longer available to him

It seems probable that this change in Henry's station in the household—the reduction of his power to command a major part of his parents' attention and the cessation of his success in gaining what he wanted by crying for it—was responsible for the development of that aggressive character of his behavior which we have already described. He had learned to expect more in the nature of gratification of his wants than had his two brothers, and it is not unnatural that as he grew older he should continue in his attempt to gratify his wants at the expense of others, if no longer successfully by crying, then by any other means at hand The fact that he more frequently resorts to temper tantrums than do his brothers is further evidence of the influence which may have been exerted by the unusual degree of attention afforded him during his first eight months of existence and the sudden withdrawal of that attention.

Possibly of some importance in this situation is the absence of punishment from Henry's early experience Whether lack of early punishment and consequent lack of early fear of parents is associated with the later development of a heightened curiosity has not been established, but it seems not improbable that in this instance such may be the case. Certainly many children refrain from exploring new situations either from fear of parents or of objects

The emotional environment of Fred and John has been very much alike with one exception After Henry returned to a more normal physical state, the mother's attention, which had been rather strongly centered upon him, was partially released for his two brothers. Whether by chance or by reason of the fact that he was next in size, his mother's affection and attention seems to have swung more to John than to Fred Although the mother steadfastly denies that she has any favorites among the three, she says that John misbehaves less often, and that he is more inclined to try to please her than are his brothers She frequently speaks of him as "mother's boy" How much of this bond was, in the beginning, the result of the mother's shifting of affection from Henry and how much of it was due to initiative on John's part, is impossible to state accurately Those of us who have been watching the situation from its beginning feel that it was largely the former.

The alliance does not at the present time extend to the point where John is immune to punishment for misbehavior The mother is very sensible on this point and seems just as quick to punish his misdemeanors as those of his brothers. We feel that this alliance has been one important factor in the behavior exhibited by John It seems to have robbed him of some of his self-reliance and to have made him rely upon his mother's sympathy and assistance in maintaining his position with the other two boys In addition, it seems to have made him less eager to form new acquaintances and investigate new situations

Aside from Henry's early period of malnutrition, all three triplets have been relatively free from illness, and upon the two occasions when illness has appeared in the group (trench mouth and dysentery) all three of them have been involved with about equal severity. There have been no injuries of importance except a painfully lacerated finger which John sustained through having a finger caught in a car door This injury occurred at the age of forty months, long after the behavior traits here discussed were well established Though the mother was hysterical over the accident at the time, she rapidly gained control of herself The finger healed without difficulty

In presenting a description of environmental differences, we realize that there are certain factors of possible importance which we have not fully accounted for Lange (1) discusses the conditions which he believes may upon occasion produce dissimilarities in twins or triplets of unioval origin:

1. Unequal prenatal nutrition
2. Intoxications due to diseases of the mother
3. Possibility of cerebral hemorrhage as a result of pertussis
4. Variations in severity of illness

He states further, however, that a large part of the differences of behavior of monozygotic twins is due to the influence of relatives who try to stimulate the children to be different

In the case of the triplets discussed here, unequal prenatal nutrition was very probably the cause of Henry's early nutritional difficulties since at birth he would have a smaller nutritional reserve than would the other two, and might conceivably have an alimentary system more immature and less able to handle artificial milk mixtures. We believe that the possibility of one triplet's suffering from an intoxication as a result of a mother's illness without the others' being affected is slight However, there is no proof that such a situation is impossible There have been no apparent differences in illness aside from Henry's nutrition disturbance in the lives of the triplets They have never suffered from pertussis The matter of birth injury has not been mentioned Since Fred, the largest, was the first born, little difficulty should have been experienced in the passage of John and Henry through the birth canal While Fred has shown no evidence of birth injury, cerebral hemorrhage from that cause cannot be entirely excluded as a possible cause of differences. We have seen no attempt on the part of the parents to stimulate the children to differences of behavior.

Shortly after the above description of the triplets' behavior was written, John, Henry, and Fred were brought in to the research institute for a physical check-up They were seen here by two new members of the staff who had read the behavior description but had never seen the triplets Both were able to recognize each of the three by his behavior within a few minutes of the time they saw the children One of these staff members saw the children as a group and had the advantage of an opportunity for comparison The other saw only one child at a time

Summary and Conclusions

1 A behavior study of a set of identical boy triplets has been presented. Uniovular triplets were chosen for the study in order that the factor of heredity might be ignored as a cause of differences in behavior

2 Observations were made over a period of two and one-half

years The major differences in the behavior of the children may be summarized as follows:

a Henry excels in leadership and aggressiveness He is less timid and more inquisitive than either of the other two

b John is the most sensitive of the three to criticism and punishment He obeys parents better and seems to make a greater effort to win his mother's approval than do the others

c. Fred's behavior is characterized by less timidity and obedience than John's, and less curiosity, leadership, and aggressiveness than Henry's

3 Differences in environment of the trio have been described. Briefly, these differences are

a Excessive attention shown Henry during the first eight months of life due to a prolonged period of malnutrition.

b. Withdrawal of the attention upon his recovery

c An emotional alliance between John and his mother that began about the end of the first year and still exists

4 The behavior differences described are probably associated with environmental dissimilarities

5 We propose to continue our observations on the behavior and environment of these triplets in order to determine, if possible, the relationship of these differences in preschool behavior to any adolescent personality differences We wish also to observe the effects of future differences in environment and their possible effects upon behavior

REFERENCES

1 LANGE, J The factors of inheritance and environment in studies of twins *Zsch f Kinderhk*, 1928, **34**, 377

2 SONTAG, L W, & NELSON, V L A comparison of the physical and mental traits of a set of identical triplets *J Hered*, 1933 (in press)

The Samuel S Fels Fund for Research in Prenatal and Postnatal Environment

Antioch College Yellow Springs, Ohio

LES TRIPLETS MONOZYGOTES DICHORIONES PARTIE II LE COMPORTEMENT D'UN GROUPE DE TRIPLETS IDENTIQUES

(Resumé)

On a employe un groupe de triplets uniovulaires pour l'etude du comportement et du milieu pour éliminer le facteur d'herédite comme consideration nécessaire On a trouve qu'un des triplets, Henri, a été plus aggressif, moins susceptible à la punition, plus curieux, plus malin, et a montre un esprit plus directeur que ses freres uniovulaires, Jean et Fréderic Jean a ete le

plus sensible et timide, et le moins agressif et malin. Le comportement de Fréderic a montré un esprit moins directeur et aggressif que celui d'Henri mais plus que celui de Jean. Les auteurs ont suggéré la relation possible entre ces différences de comportement et la différence de milieu des trois triplets. Quoiqu'ils aient demeuré tous les trois dans la même famille et aient été en contact quotidien avec les mêmes gens, Henri, à cause d'une période d'inanition à un âge peu avancé, a reçu la plupart de l'attention de la famille et à l'âge de neuf mois a été très gâté. La perte de cette attention familiale exaggérée n'a pas éliminé, paraît-il, les traits de son comportement lesquels en ont résulté. Après qu'Henri a été forcé à perdre l'attention familiale, Jean a développé une alliance avec sa mère laquelle existe toujours. C'est pendant cette alliance que les particularités de son comportement déjà citées se sont montrées.

Les auteurs proposent de continuer l'observation du comportement et du milieu de ces enfants et de les rapporter encore à un âge plus avancé. Ils suggèrent un emploi plus général des jumeaux et des triplets identiques pour les études d'hérédité et de milieu.

SONTAG ET NELSON

MONOZYGOTISCHE, DICHORIONISCHE DRILLINGE. ZWEITER TEIL: DAS BETRAGEN EINER GRUPPE IDENTISCHER DRILLINGE

(Referat)

Eine Drillingsgruppe, aus einem einzigen Ei [uniovular], wurde zu einer Untersuchung des Betragens [behavior] und der Umgebung benutzt um die Notwendigkeit der Berucksichtigung der Einwirkung der Umgebung auszuschalten. Es zeigte sich, dass Henry, einer der Drillinge, aggressiver, fur Strafe weniger empfindlich, neugieriger, und schalkhaftiger war, und mehr dirigierte, als seine Bruder aus dem selben Ei, John und Fred. John war der empfindlichste und scheuste, und am wenigsten aggressiv und schalkhaft. Fred's Benehmen zeigte weniger Fuhrerschaft und Aggressivitat als Henry's, aber mehr als John's. Die Verfasser weisen auf die Moglichkeit einer Beziehung zwischen diesen Unterschieden im Benehmen und den Unterschieden zwischen den Umgebungen der drei. Obwohl sie im selben Hause wohnten und mit den selben Menschen in taglicher Beziehung standen, erhielt Henry, infolge eines anfanglichen Entkraftungszustandes, einen grossen Teil der Aufmerksamkeit der Familie und war mit neun Monaten stark verwohnt. Die Zuruckziehung der uberflussigen Aufmerksamkeit der Familie scheint die daraus entstehenden Eigenschaften seines Betragens nicht eliminiert zu haben. Nachdem Henry gezwungen worden war, die Aufmerkssamkeit der Familie aufzugeben, entwickelte John einen Bund mit seiner Mutter die bis jetzt noch besteht. Wahrend des Bestehens dieses Bundes haben sich die schon erwahnten Eigentumlichkeiten seines Benehmens sehen lassen.

Die Verfasser beabsichtigen, die Beobachtung des Benehmens und der Umgebung dieser Kinder fortzusetzen und uber sie, wenn sie alter sind, weiter Bericht zu erstatten. Sie weisen auf die Nutzlichkeit einer mehr allgemeinen Benutzung der Zwillinge und Drillinge zu Untersuchungen der Hereditat und der Umgebung hin.

SONTAG UND NELSON

PREFERENCES IN THE REPETITION OF SUCCESSFUL AND UNSUCCESSFUL ACTIVITIES AS A FUNCTION OF AGE AND PERSONALITY*

From the Psychological Clinic, Harvard University

SAUL ROSENZWEIG

It was the object of the present experiment to determine whether individuals prefer to repeat activities in which success or activities in which failure has previously been experienced. The relation and importance of this problem to the psychology of personality development are too obvious to require discussion.

The experimentees[1] were 37 children at the Peabody Home for Crippled Children in Newton, Massachusetts.[2] There were 22 boys and 15 girls. They ranged in age from 5 years and 6 months to 14 years and 8 months, with a median age of 8 years and 10 months.

The experimental material consisted of two jig-saw puzzles (A and B), each having five pieces or blocks which formed a board 1 foot square and ½ inch thick when assembled correctly. The original boards were neither painted nor decorated and were cut with the intention of constructing puzzles of approximately equal difficulty. To what extent this purpose was achieved may be inferred from the following facts. The average time consumed by

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[1]In this paper the term "experimentee" (abbreviated Ee) will be used in lieu of either "subject" or "observer." Without going at any length into the reasons for this usage, we may mention that our Ees were not strictly "subjects," in the sense of behavioral animals, nor were they "observers," in the Titchenerian meaning of this designation. [Cf. the controversy between Dashiell and Bentley (3, 4, 6, 7).] They were in part both, and the term "experimentee" covers this general function. It is, moreover, the natural correlative to the term "experimenter" (Er) and the exact equivalent of the German "*Versuchsperson*."

[2]This opportunity may be taken to extend our thanks to Mrs. N. S. Smith, Miss Vivian Jewett, and Miss Anita Daniels of the Peabody Home for their kind interest and cooperation.

Puzzle A in those cases in which completion was allowed was 4 minutes and 57 seconds, and by Puzzle B, under similar circumstances, 4 minutes and 2 seconds. The range of time spent upon the puzzles, whether with or without success, was from 15 seconds to 16 minutes and 30 seconds. On the average, each puzzle consumed about 4 minutes.

The procedure of the experiment was as follows The children were brought individually into a room and seated before a table On the table, in the center, was a heavy cardboard 1 foot square The Er asked the Ee for his name and age and then conversed with him for a few moments so as to gain some impression of the child's personality as well as to put him at his ease The following instructions were then given:

> "I am going to ask you to do some puzzles for me to see how well you can do and how much better than the other children You must do them as fast as you can for you can have only a certain time for each of them and if you don't finish in time you will have to stop Do the best you can
>
> "Try this one. Put the pieces together so that they make a square as big as this one (The Er pointed to the cardboard on the table before the Ee) Do the puzzles on this board, it will help you"

Two puzzles were given in the test and every Ee was allowed to finish one of the puzzles successfully to the end but was frustrated on the other by being stopped before he had completed it The timing was made obvious so as to arouse the Ees It was intended that the Ees should be under the impression that they were being allowed an amount of time established beforehand and equal for all the Ees. They were not to know that the time allowed was an arbitrary matter determined by the Er for some other purpose than that of testing ability

After the first puzzle, a second was presented with the instruction. "Now try this one in the same way"

The Er attempted to control the order in which Puzzles A and B were presented and in which success and failure were induced in the different cases, so as to rule out experimental artifacts The results (cf. Table 1) showed that this attempt was highly successful In 20 of the 37 cases Puzzle A was given before B; in 17, Puzzle B was given before A In 18 cases success (which will henceforth be symbolized by "C") was induced before failure (henceforth sym-

TABLE 1
SUMMARY OF EXPERIMENTAL DATA

Name	CA	MA	IQ	First puzzle A or B	First puzzle Time m-s	First puzzle C or X	Second puzzle A or B	Second puzzle Time m-s	Second puzzle C or X	H P	R P	1st P R	2nd P.R.
G L	5-6	5-5	98	A	6-05	X	B	4-35	C	C	C	+2	+1
M McI	6-0	4-2	69	A	14-00	C	B	4-25	X	C	C	—2	—3
W T	6-2	4-3	69	B	4-03	C	A	2-35	X	C	C	—1	—3
A Pe	6-2	5-8	92	A	8-20	C	B	2-43	X	C	C	+1	+1
M McD	6-6	4-2	64	B	4-12	X	A	4-38	C	C	C	—1	—3
E K	6-7	5-9	87	B	4-50	X	A	5-15	C	C	C	+1	0
C D	6-9	6-5	95	A	0-52	C	B	1-02	X	C	C	+1	+1
B L	7-2	6-10	95	A	3-24	C	B	3-40	X	C	C	—1	—1
W D	7-2	8-0	112	B	7-15	X	A	7-30	C	C	C	+2	+3
W G	7-8	6-11	90	A	2-06	C	B	2-13	X	C	C	—2	—1
L H	7-10	7-4	94	A	4-30	X	B	4-08	C	C	X	+1	—2
L A	8-0	8-1	101	A	0-45	C	B	0-15	X	C	X	+3	+2
E M	8-3	7-11	96	B	7-00	C	A	2-00	X	C	C	—2	+1
L C	8-3	6-9	82	A	6-00	X	B	16-30	C	C	C	+2	+2
M C	8-4	8-0	96	B	1-00	C	A	1-00	X	C	C	+2	0
F F	8-7	8-4	97	B	4-00	C	A	4-00	X	C	X	+1	+1
B W	8-8	8-3	95	A	1-17	C	B	0-50	X	X	X	+2	+3
R B	8-9	8-0	91	A	9-00	X	B	3-00	C	X	C	—2	—3
J B	8-10	8-5	95	A	5-40	X	B	6-00	C	C	C	—1	+1
M R	9-1	8-2	90	B	0-40	C	A	5-00	X	C	C	—1	+2
F Ca	9-2	8-5	92	B	5-00	X	A	12-00	C	C	C	+1	—2
M J	9-8	6-9	70	B	3-30	X	A	5-00	C	C	C	—2	—3
W A	9-10	9-1	92	A	10-00	X	B	0-47	C	C	X	—2	—1
A G	10-0	9-11	99	A	2-15	C	B	2-45	X	C	X	+3	+3
F Co	10-5	10-11	105	A	11-30	X	B	1-55	C	X	X	+2	+1
C M	10-7	8-8	82	A	6-00	X	B	5-40	C	C	X	+2	+2
P H	10-7	8-1	76	B	2-10	C	A	1-30	X	C	C	+1	+1
R P	11-2	8-2	73	A	5-00	C	B	2-25	X	C	C	+1	+1
A D	11-2	12-1	108	B	3-30	X	A	1-28	C	C	X	+2	—1
S A	11-2	8-11	80	A	1-50	C	B	1-50	X	C	X	—2	+1
F D	12-0	11-2	93	A	4-00	X	B	7-00	C	X	X	+2	+2
A Pa	13-2	11-1	84	B	2-00	C	A	1-05	X	C	X	+3	+2
A O	13-10	8-5	61	A	2-32	X	B	1-03	C	X	X	+3	—1
W W	14-0	13-2	94	B	1-20	C	A	0-30	X	C	X	+1	+2
W Y	14-4	11-11	83	B	1-22	X	A	13-10	C	C	X	+3	—1
N A	14-4	12-2	85	B	1-00	X	A	2-30	C	C	X	+2	+2
C R	14-8	11-9	80	B	1-05	X	A	2-47	C	C	X	+2	+3

CA = Chronological age
MA = Mental age
IQ = Intelligence quotient

H P = Hedonic preference
R.P = Repetition preference
P.R = Pride rating

bolized by "X"), in 19 cases X preceded C Combining these two variables, Puzzle A resulted in C 19 times, in X 18 times, Puzzle B resulted in C 18 times, in X 19 times

After the second puzzle, the Er asked the question · "Which puzzle did you like better, the first one or the second one?" In about a third of the cases, selected at random, the further question "Why?" was then put

The form of the first question requires a word of explanation The Er did not ask the children which of the experiences they had found more pleasant, he asked which of the two puzzles the Ees had liked the better This manner of interrogation was adopted because it was considered to be the most suitable for children. To the Er the formulation in terms of "finding an experience pleasant" seemed foreign to the child's way of thinking and feeling, hence the more objective manner of interrogation The fact that the results thus obtained were univocal and consistent with what one obtains from adults, to whom the question has been put in the other form, is in part a justification of this procedure [3]

The results of the experiment show that success is hedonically preferred to failure Of the 37 Ees, 32 preferred C, 5 preferred X

It is worthy of note that the five negative results came from children whose ages lay very close to or above the median age for the entire group The median age for the 37 cases was 8 years and 10 months, for the 5 negative cases, the median age was 10 years and 5 months This relatively greater age of the negative cases seems to indicate that the objective formulation of the question of preference was less satisfactory with older individuals because it was taken to refer not to previous experience but to prospective experience It is as if the older Ees considered that they were being asked to designate the puzzle that they regarded as the more *interesting*, the one that it *would be* more pleasant to master

We may now consider the reasons that the Ees assigned for their preferences Thirteen of the Ees were asked to make such reports, and Table 2 summarizes the results.

The table shows that ease or difficulty was the only reason assigned for hedonic preference It is also clear, however, that there was no univocal relation between ease or difficulty and preference, for a puzzle may be liked less by one Ee for the same apparent reason

[3]Cf in confirmation a recent note by Hunt (12)

TABLE 2

Reasons Assigned for Hedonic Preferences

Reasons for preferring C	Reasons for preferring X
Don't know why	It was harder I like hard things—if it's puzzles
It's easy	It's harder.
It's hardest	'Cause it was harder If it's easy, it's no fun
It's easy.	I like hard things
It's easier	
I could do it better	
Don't know	
The second (X) got too much on	
It was easiest	

that it is liked better by another—the reason being, of course, the difficulty of the puzzle This teaches us the importance of scrutinizing very closely the form of the question we put to our Ees and the manner in which they understand this question

It remains to point out the unreliability of the answers from an objective standpoint, or, to put it more psychologically, the subjectivity of the reasons assigned by the Ees What we mean is that it is not important whether a puzzle is objectively harder or easier when hedonic preferences are considered A puzzle on which an Ee succeeds is *ipso facto* usually regarded as "easier," i e, easier *for him* Likewise, if he fails, the puzzle on which he fails is *ipso facto* "harder," i e, harder *for him*. The meaning of the experience is the important point

The significance of these findings to the general problem of the conditions for hedonic tone is obvious Our results harmonize very well with W McDougall's (13) theory that pleasantness and unpleasantness are conditioned upon the success and failure of conation, respectively, and with some of the formulations of N Ach (1) relative to "determined feelings."

We come now to the crucial part of this experiment In addition to the question just discussed, the Ees were given the following instructions after the test

> "I want you to do one of these puzzles again You may do either one—the first or the second Which would you rather do again?"[4]

[4]The order in which the questions on hedonic and repetition preference were put is discussed below

The Ees were then allowed to execute the preference expressed In some cases (to be discussed later) the Ee was first asked whether he wanted to do *either* of the puzzles again and was then asked *which* he preferred to repeat.

The results of the present experiment were that, of the 37 Ees, 20 preferred to repeat the puzzle on which success (C) had been experienced and 17 the one on which failure (X) had been experienced.[5] The fact that the choices were so evenly divided between C and X might seem to point to chance as the explanation, but inspection of all the data soon reveals a clear relationship between the type of choice and certain other factors

1. One of these factors is chronological age Of the 10 youngest Ees, 10 preferred to repeat C, 0 to repeat X, of the 10 oldest Ees, 1 preferred to repeat C, 9 to repeat X, of the 17 of intermediate age, 9 preferred to repeat C, 8 to repeat X Expressing this relationship in another way, the median chronological age of all the Ees who preferred to repeat C was 8 years, of the Ees who preferred to repeat X, 11 years and 2 months[6] If we calculate Yule's coefficient of association for the relation between chronological age below or above the median age for the whole group, on the one hand, and preference to repeat C or X, on the other, we find that $Q = 80$ The accompanying graph (Figure 1) shows this relationship very clearly

2. Certain personality ratings assigned by the two teachers in charge of the children make possible a second correlation. These teachers were asked to rate each child on a scale ranging from —3 through +3 on *pride* or desire to excel Pride was defined as follows· "Desire to stand well with the group, and pleasure in one's own achievement."

The *first pride rating* was made by the two teachers in charge of the children with whom we were experimenting, each teacher rating her own children One of the teachers had 27, the other

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[5]Cf in this connection the work of Ovsiankina (14) Working mainly with adults, Ovsiankina found that unfinished tasks are much more frequently resumed than finished ones In the light of our findings, we should be inclined to question whether this may be said of children with as much certainty as it may be said of adults.

[6]The consideration forces itself upon us that no very high predictive significance can be attached to the exact numerical values of these averages because our Ees were crippled and institutionalized Both of these conditions would make age comparisons with other children hazardous It is our impression that the average ages for normal children preferring to repeat C or X would be lower than the ones here recorded

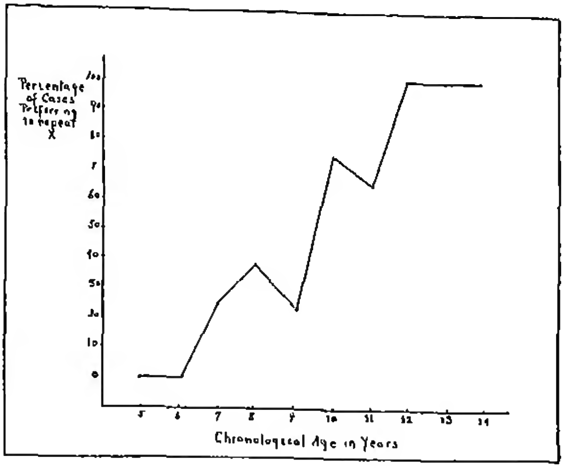

FIGURE 1

Relation of Chronological Age to Repetition of Unsuccessful Puzzles

had 30 of the children In order to take into account any difference between the standards of the two teachers in the assignment of grades, a *second pride rating* was requested some months after the first had been made, but this time the teacher who was in general charge of all the children and who had previously rated the group of 27 was requested, without consulting her previous ratings, to rate *all* of the children. In the results now to be presented both of these ratings figure.

The average of the first pride ratings for all the Ees repeating C was — 05, for all the Ees repeating X, +1 65 The average of the second pride ratings for all the Ees repeating C was — 25, for all the Ees repeating X, +1 06

This relationship between pride rating and repetition preference, on the one hand, and the previously noted relationships of age and type of preference, on the other, would lead us to expect a direct relationship between the size of the pride rating and chronological age Dividing the Ees into two groups, one below, the other above the median for all the Ees in respect to chronological age, we find that the average of the first pride ratings for the former group was + 39, for the latter +1 17, the average of the second pride ratings for the former group was — 06, for the latter + 72

Certain qualitative findings confirm this indication. The older children seemed to be much more conscious of the fact that they were being tested and gave more external signs of tension than did the younger Sometimes the older children asked about the success of children previously tested The younger ones seldom did this In several cases the younger children—5 and 6 years old—asked to be helped by being told whether or not they were right as far as they had gone with a particular puzzle, and in two or three such cases, in order to keep the Ees interested, it was necessary to give an answer to these questions The older children did not expect to be given, and practically never asked for, such information

The reasons spontaneously offered by the older children when indicating their repetition preferences should also be noted. Among such remarks were the following "I'd like to see if I can get it" "I *want to get that one done.*" "I *want to learn how to do it.*"

In concluding the discussion of the relationship between repetition preference, age, and pride ratings, two final points should be made The first of these is that it was not age in itself, but something associated with age, that was apparently responsible for the type of repetition preference Of the 8 cases ranging in age from 8 years to 8 years and 10 months, and thus being only slightly different in this respect, the 5 who preferred to repeat C had an average first pride rating of —20 and a second of +.20, whereas the 3 who preferred to repeat X had an average first pride rating of +2 and a second of +2 Difference in pride therefore seems to distinguish individuals in respect to their repetition choice even when age is a constant factor

The second point is that one should be careful in generalizing from the results of the present experiment, owing to the fact that we have been working with a certain type of task, namely, the performance of puzzles as a test of ability. Though our Ees under the conditions of the present experiment fell into certain groups with certain relationships, this is no warrant for assuming that they would be similarly aligned for all types of tasks This consideration would be of special importance if one were to attempt to compare two individuals of the same age in respect to pride by such a test as ours, for it might well be that an individual with a highly developed pride sentiment in respect to one type of task would have quite a low one in respect to another type It does, however, seem safe to attach some general importance to our results as an indication of the growth of pride

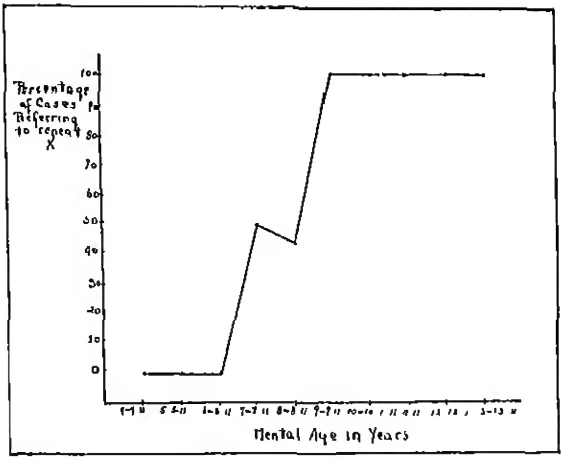

FIGURE 2

Relation of Mental Age to Repetition of Unsuccessful Puzzles

3 A third factor that presents itself for consideration is mental age To measure mental age the Ees were given the Kuhlman-Anderson tests for intelligence The relationship between the mental ages thus obtained and repetition preference is shown in Figure 2. From this it is clear that there is a highly significant co-variation of these two factors.

This is not surprising *in view of the previously demonstrated* relation of chronological age to repetition preference. It is to be expected that, on the whole, mental age will increase with chronological age and that, if repetition preference is a function of the latter, it will also appear as a function of the former As a matter of fact, however, the relationship between repetition preference and mental age seems to be more marked than that between repetition preference and chronological age; for whereas Yule's coefficient of association for the latter was 80, for the former it was 95

One questions the significance of this relationship, however, as a result of the following analysis Taking all the cases in which the mental age was between 8 years and 8 years and 11 months—this year being selected because more cases fell within it than within any other equally narrow range of mental ages—one finds that 8 preferred to

repeat C and 6 to repeat X, though the mental ages of the two groups were practically equal Moreover, if these two groups are compared in respect to pride ratings, it is found that the former or C group had an average first pride rating of + 38 and a second of +.38; the latter or X group had an average first pride rating of +1 50 and a second of +1.33. Where mental age does not differentiate the groups in a significant way, pride ratings still do

Evidence which may be cited from the recent psychological literature points in the same direction. C G Aldrich and E A Doll (2) have studied the comparative intelligence of 12 idiot boys with life ages from 8 to 15 years and mental ages from 19 to 38 months, on the one hand, and of 12 normal infant boys with life ages from 19 to 38 months, on the other. In reporting their results these authors write as follows

> "The normal children seemed to recognize their own limitations more quickly than did the idiot children Once having found a task too difficult, no amount of urging could persuade them to continue their efforts The idiot child, however, could often be urged to continue trying regardless of the apparent futility of his efforts. This may be an indication either of superior self-criticism among the normal children, or of impatience to proceed to the next task There is, of course, no means of ascertaining whether or not those children who gave up could have succeeded with continued effort" (2, p 254).

This seems to indicate that, where one has two groups of children of comparatively equal mental age but of decidedly different chronological age, the group younger chronologically displays less doggedness than does the older Whether or not such is actually the case should be shown by an experiment we are now planning in which the repetition preference of feebleminded children is to be compared with that of normal children. It is impossible to say on the basis of our present data whether the correlation of repetition preference with chronological age is to be explained by reference to an intellectual factor measured by mental age or by reference to a dispositional factor, namely, pride, or both

Before leaving the matter of mental age, it is well to call attention to the relatively low intelligence quotients of the children with whom we were working We used the Kuhlman-Anderson tests for the purpose of measuring the intelligence of our Ees, and the obvious dependence of success in these tests upon school work—of

which these crippled children had naturally not had a full share—makes one skeptical of the validity of these measures But even if our Ees were less than normal in intellectual ability, it does not seem that this would affect our conclusions very much

We turn now to a discussion of certain experimental artifacts that may have influenced the results thus far reported We shall review three sets of these in turn, attempting to evaluate each.

1 The first of these is the *ratio between the ease or difficulty of* the puzzles and the ability of the Ees. Is it not possible that if the puzzles given the younger children had been as easy for them as the puzzles we used were for the older children, then the younger children, too, would have preferred to repeat X? F Hoppe's (11) investigation of the effects of previous successes and failures upon the *Anspruchsniveau* or level of aspiration would lead us to expect that if the X puzzle of the younger child was felt by him to be definitely beyond his ability, then he would revert to a lower level of aspiration and repeat C; whereas the older child, if he did not consider the X puzzle beyond his ability, would not necessarily reduce his *Anspruchsniveau* but would continue to persevere, thus repeating X

In general, however, it would seem that a puzzle of five pieces is not too hard to expect a child of six or seven to solve, nor is an average time of about four minutes very long to work on a puzzle. Moreover, if the Ees are divided into two groups according to whether they preferred to repeat C or X, it is found that, of the 20 Ees in the C group, 6 preferred to repeat the puzzle on which less time had been spent, 13 the puzzle on which more time had been spent Of the 17 Ees in the X group, 8 preferred to repeat the puzzle on which less time had been spent, 7 the puzzle on which more time had been spent.[7] The significant point is in connection with the C group, for here it is found that over twice as many Ees had spent longer on the C puzzle than on the X puzzle, but that, in spite of this, all of them preferred C for repetition If the difficulty of the X puzzle—as measured by time consumed—were of decisive importance in determining repetition preference, this result would have been impossible One is thus led to believe that it was not so much any objective difficulty of the puzzles but some other

[7]In the C group, one Ee spent an equal amount of time on both the puzzles, in the X group, two did so

factor, perhaps the extent to which the Ees were determined to succeed, that made the difference in repetition preference.

Another method of analysis that points in the same direction is the following. We now take as our basis not the relative difficulty of the puzzles for the Ees but an equal degree of ability as measured by mental age scores. In the group of Ees with mental ages from 8 years to 8 years and 11 months, it was found that, though all the Ees were of approximately equal ability (as measured by mental age scores), 8 of these preferred to repeat C, 6 to repeat X Difference in ability fails to account for repetition preference Moreover, here where difference in ability will not account for repetition preference, pride ratings do seem to, for the 8 Ees who preferred to repeat C had an average first pride rating of +.38 and a second of +.38; whereas the 6 who preferred to repeat X had an average first pride rating of +1.50 and a second of +1.33.

Though we cannot, without further experimentation, conclusively evaluate the importance of the difficulty of the puzzles in determining repetition preference, we are for the above reasons inclined to believe that in our experiment it did not play a decisive part

2 A further group of artificial factors that may have had some effect in determining the type of repetition preference comes under the heading of suggestion This influence might arise from the social situation between the Er and the Ee We must consider first the influence of the Er upon the expression of *any* preference to repeat either C or X, and, secondly, the influence of the Er upon the *particular type* of preference expressed—for C or for X.

One may wonder whether the Ees actually desired to repeat the puzzles or expressed a preference only because the Er asked a question which presupposed further interest in the puzzles It is not difficult to appreciate the possibility of a submissive attitude of the child toward the Er. In regard to this we may say that from the way in which the choices were made by the Ees—their general attitude as expressed in words or actions at the time of choosing—it seems that in some cases at least there was a real desire to repeat one of the puzzles, whether it was a finished or an unfinished one as the case might be. It would seem that the opportunity to do one of the puzzles again was exactly what the Ee had been hoping for, if one may judge from the alacrity with which he greeted it and the way in which he attacked the puzzle upon being given it again.

Furthermore, we have evidence from 10 cases in which the Er asked the Ee whether he would like to do either of the puzzles again before asking for the particular preference, that 8 answered in the affirmative and 2 in the negative Even here, however, the Ee may have been answering in accordance with what he thought the Er wanted, so that we cannot infer a true desire to work any further with the puzzles. But, on the whole, it would seem that the Ees really did wish to work at the puzzles after having finished the first two performances

Whether the type of preference was influenced by the Er is the next problem It is possible that the prestige of the Er tended to inspire the child with a fear of censure unless he chose in a certain way or with a hope that he would be praised in case he chose in a certain way. The choice might then have been in accordance with the child's fear or hope But in either situation one would still have left the fact that one group of Ees was moved by the Er so that preference for C was expressed, another group was moved to express preference for X, and this difference would still have to be explained To what extent such an influence was actually exerted it is impossible to ascertain, but to circumvent this problem the choice of the Ee should be made under conditions in which the Er would have no part, he might leave the room, informing the child before so doing that if he desired he might play with one of the puzzles

3. A final group of artifacts we must take into account is connected with the technical procedure of the experiment For one thing, it should be recalled that the question of repetition choice was put to the Ee either before or after another question relative to hedonic preference. May it not be that the question as to hedonic preference and the answer to this influenced the answer to the question on repetition? This would be possible only in case the former question preceded the latter, and we find from our records that in nearly all cases—33 of 37—this was actually so Assuming such an influence, however, it would still be necessary to ask why the influence was not the same for all the Ees, or, in other words, why about half the Ees chose C, the other half X To this the answer that the younger children were more suggestible may be made, but this might itself reduce to difference in pride or intellectual maturity Further experimentation on this problem should avoid this difficulty by omitting all other questions but the one on repetition preference

The nature of the particular puzzles and their order are other

technical factors that ought to be considered It has already been said that the Er alternated Puzzles A and B in respect to order and in respect to success and failure The extent to which such factors were successfully offset may be inferred from the following facts: Of the group who preferred to repeat C, 11 had A as C, 9 had A as X, of the group who preferred to repeat X, 8 had A as C, 9 had A as X Of the C group of Ees, 10 had A first, 10 had B first, of the X group, 10 had A first, 7 had B first Of the former group, 11 had C first, 9 had X first, of the latter group, 7 had C first, 10 had X first This represents a successful alternation of these technical factors and we may therefore consider that they were not of any significant importance in determining our results

We may summarize the results of the foregoing discussion as follows:

1 Repetition of C or X correlates with chronological age The younger children, in general, preferred to repeat C, the older, in general, X.

2. Repetition of C or X correlates with differences in ratings of the trait of pride Those who preferred to repeat C had a lower average pride rating than those who preferred to repeat X.

3. Repetition of C or X correlates with mental age Those who preferred to repeat C had a lower average mental age than those who preferred to repeat X

These facts of correlation were apparently not influenced, to any great extent, by the following experimental artifacts.

1 The difficulty of the puzzle in relation to the ability of the Ee

2. The suggestive influence of the Er upon the Ee

3 The technical errors that might arise from the order in which the particular puzzles were given and in which success and failure were induced.

In conclusion, we may attempt to interpret the data on repetition preference from a theoretical standpoint Two questions are possible. (1) Why did the younger children prefer to repeat C rather than X? (2) Why did the older children prefer to repeat X rather than C? Of these two questions—and they are really two though they appear to be reciprocals of each other—we shall concern ourselves mainly with the latter, referring to the former at

times by way of comparison [8] We shall limit the discussion in this way because the unfinished state of the experimental work on this problem warrants no more

It seems to us that the difference in persistence of those who preferred to repeat C and those who preferred to repeat X was mainly a matter of the extent to which failure was wounding to them The younger children apparently felt no need to vindicate themselves after failure The fact of incompletion probably signified to them simply an objective situation to be avoided on future occasions The older children, on the other hand, were apparently more vulnerable Not being able to finish a puzzle was experienced as a rankling hurt to their pride They would therefore seize the first opportunity to vindicate themselves and demonstrate their superiority This theoretical interpretation of the difference between the two groups seems to be borne out by the correlations with *ratings of pride* that we found.

The need for vindication, of which, according to our hypothesis, those children who preferred to repeat X experienced more than did those who preferred to repeat C, may be thought of as related to the socialization of the individual in a competitive milieu Those who preferred to repeat X were presumably more eager to make a good showing in relation to the other children with whom they were told they were being compared, and were more sensitive to the opinion of others as to their ability. A difference in *mental age* or intellectual maturity related to education may thus also have been involved, as our results tended to show

To substantiate this notion of socialization it is worth mentioning that one of the questions that all the Ees were asked in the short interview before the test was, "Do you like to play with the other children or would you rather play by yourself?" Only 8 of the Ees stated an unequivocal preference for playing alone, and, of these 8, 7 were children who had preferred to repeat C [9] The indica-

[8]A complete treatment of the former question would involve a discussion of the repetitive behavior of young children (cf Drummond, 8) The repetition of C may be regarded as an example of infantile repetitive behavior, or, what is more probable, as an attempt to master a material obstacle Our main concern, however, is to show why the older children did not repeat previous successes but *attempted to turn previous failure into success*

[9]In confirmation of this result, cf the study of children's play by Hetzer, who found that before the age of three years competitive games do not occur Between the ages of three and six, only 8% of the games involve rivalry—Cited after Greenberg (10, p 222)

tion of this result is that those who preferred to repeat C were less socialized. Being less socialized, they would be less sensitive to the opinion of others as to their ability and would hence not need to repeat X in order to vindicate themselves.

Our findings are thus significantly related to the work of J. Piaget (15). From an intensive investigation of the development of thinking in young children he has found that "To put it quite simply, . . the adult thinks socially, even when he is alone, and that the child under seven thinks ego-centrically, even in the society of others" (p. 40) The young child lives in a world of his own; he has not yet adapted himself to external reality He adds elsewhere, ". . . the decrease in egocentricity which becomes very marked after the ages of 7 or 8 is due as has been shown elsewhere (*Language and Thought,* Chapters I-III) to the manner in which child thought becomes progressively socialized" (16, p. 385).[10] It may then be said that *conscientiousness,* whether in thinking or in acting, appears to be a function of socialization The Freudian concept of the superego with its criticizing capacities in respect to both thought and conduct thus gains confirmation.

It will be recalled that the Ees in this experiment were asked to state which of the two puzzles they had done they had liked the better. If the answers to this question are combined with the results on repetition preference, it follows that those who preferred to repeat C wanted to have again an experience that was *once liked,* on the other hand, those who preferred to repeat X wanted to resume an experience that was *previously not liked,* but which they presumably *would have liked* to rectify The relation of this distinction to the concept of regression in psychopathology is evident. The neurotic in his behavior regresses to the type of preference characteristic of our younger Ees. Instead of doing what he would like and which is perhaps too much for him, he does what once he did like and which is easily possible again Unable to adapt himself socially and so go progressively forward, he becomes asocial and goes regressively backward The phenomena of child psychology thus seem to shed light upon those of abnormal psychology.

Summary

In an experiment on 37 children ranging in age from about 5 to 14 years, it was found that of two simple jig-saw puzzles done as

[10]Cf also Freud (9), and Buhler (5, pp 156-208) The recent work of Greenberg (10) supports our conclusions.

a competitive test—one puzzle resulting in success, the other in failure—32 of the 37 Ees reported that they liked better the puzzle on which success was met. This corroborates the type of hedonic theory held by McDougall that pleasantness is conditioned upon the success of conation Of the 37 Ees, 20 preferred to repeat the successful, 17 *the unsuccessful puzzle. In general, those of the former* group differed from the latter in being younger, both chronologically and mentally, and in having been assigned lower ratings for the trait of pride by their teachers Though these results require to be checked by further experimentation, they seem at present to indicate that with increase in age comes an increase in pride and in self-criticalness or conscientiousness, all of which entails a certain sensitiveness to failure and leads to attempts at self-vindication

References

1 Ach, N Ueber den Willensakt und das Temperament Leipzig Quelle & Meyer, 1910 Pp. 324

2 Aldrich, C G, & Doll, E A Comparative intelligence of idiots and normal infants *J Genet. Psychol*, 1931, 39, 227-257

3 Bentley, M 'Observer' and 'subject' *Amer J Psychol*, 1929, 41, 682-683

4 ———. Another note on the observer in psychology *Amer. J. Psychol*, 1930, 42, 320.

5 Buhler, C Kindheit und Jugend Genese des Bewusstseins. (*Psychol Monographien,* Vol. 2) Leipzig Hirzel, 1928 Pp. xx+307

6 Dashiell, J F Note on the use of the term observer *Psychol Rev*, 1929, 36, 550-551

7 ———. A reply to Professor Bentley *Psychol Rev*, 1930, 37, 183-185

8 Drummond, M Some contributions to child psychology London Arnold, New York Longmans, Green, 1923 Pp viii+151

9 Freud, S Concerning the two principles in mental functioning In Vol IV of *Collected papers of Sigmund Freud* London Hogarth Press & Instit Psycho-Anal, 1925 Pp 13-21

10 Greenberg, P J Competition in children an experimental study *Amer. J. Psychol.*, 1932, 44, 222-248

11. Hoppe, F Untersuchungen zur Handlungs- und Affektpsychologie, ed by K Lewin IX Erfolg und Misserfolg *Psychol Forsch*, 1930, 14, 1-62

12 Hunt, E B The genetic primacy of hedonic terms *Amer. J Psychol*, 1932, 44, 369-370

13 McDougall, W Pleasure, pain and conation *Brit J Psychol* (*Gen Sect*), 1927, 17, 171-180

14 Ovsiankina, M Untersuchungen zur Handlungs- und Affektpsychologie, ed by K Lewin VI Die Wiederaufnahme unterbrochener Handlungen *Psychol Forsch*, 1928, 11, 302-379

15 PIAGET, J The language and thought of the child (Trans by M. Warden) New York Harcourt, Brace, 1926 Pp xxiii+246

16 ——— The child's conception of the world (Trans by J Tomlinson and A Tomlinson) New York: Harcourt, Brace, 1929 Pp ix+397

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PRÉFÉRENCES DANS LA RÉPÉTITION DES ACTIVITÉS RÉUSSIES ET NON RÉUSSIES COMME FONCTION DE L'ÂGE ET DE LA PERSONNALITÉ

(Résumé)

Dans une expérience sur 37 enfants variant de l'âge de cinq ans à celui de quatorze ans, on a trouvé que de deux casse-tête simples resolus comme test de concours—l'un casse-tête réussi, l'autre non reussi—32 d'entre les 37 sujets de l'expérience ont rapporté qu'ils avaient mieux aimé le casse-tête réussi Ce résultat corrobore le type de theorie hédonique soutenue par W McDougall que la bonne humeur est conditionnée par la satisfaction de la conation Il s'accorde aussi avec certaines des formulations de N Ach à l'egard des "sentiments determinés" D'entre les 37 sujets, 20 ont mieux aimé repéter le casse-tête reussi, 17 le non réussi Ceux du premier groupe on differé de ceux du dernier en moyenne aux égards suivants. (1) Ils ont été plus jeunes en l'âge chronologique; (2) Ils ont été plus jeunes en l'âge mental, (3) Leurs maîtres leur ont donné des évaluations moins elevées pour le trait orgueil—defini comme "le desir d'etre bien aimé par le groupe et le plaisir de l'accomplissement personnel" Bien qu'il faille contrôler ces résultats au moyen d'autres experiences, ils semblent indiquer à present qu'il existe avec l'avancement de l'âge un accroissement de l'orgueil et de critique de soi-même ou conscience, ce qui comprend une certaine sensibilite à l'insuccès et amène des essais de justification de soi. Cette conclusion s'accorde avec de certains résultats de J Piaget sur le développement des procédes de critique de soi-même dans la façon de penser chez les enfants

ROSENZWEIG

BEVORZUGUNGEN BEI DER WIEDERHOLUNG ERFOLGREICHER UND NICHT-ERFOLGREICHER TATIGKEITEN ALS FUNKTION DES ALTERS UND DER PERSÖNLICHKEIT

(Referat)

In einem Versuch an 37 Kindern, die zwischen 5 und 14 Jahren alt waren, wurden zwei Zusammensetzspiele [jig-saw puzzles] als Wettprufungen ausgefuhrt. Das eine Zusammensetzspiel brachte stets Erfolg, das andere nie. *Zwei-und-dreisig der 37 Versuchspersonen meldeten,* dass ihnen das Zusammensetzspiel, das sie erfolgreich erledigen konnten, besser gefiel, als das andere. Dieser Befund bestatigt die hedonistische Theorie Wm. McDougall's, dass Lust [pleasantness] von der Befriedigung des Strebens [conation] abhangig ist. Er stimmt auch mit gewissen Formulierungen von N. Ach uber "bedingte Empfindungen" [determined feelings"] uberein. Von den 37 Vpp. zogen es 20 vor, das erfolgreiche, und 17 es vor, das nicht-erfolgreiche Zusammensetzspiel zu wiederholen. Die Kinder der ersten Gruppe waren im Allgemeinen von jenen der letzteren Gruppe in folgenden Beziehungen verschieden: (1) Sie waren kronologisch junger, (2) Sie waren geistig junger, (3) Es waren ihnen in Bezug auf die Eigenschaft des Ehrgeizes—definiert als "der Wunsch, mit der Gruppe gut zu stehen, und Gefallen an der eigenen Leistung"—von ihren Lehrern niedrigere Notierungen gegeben worden. Obwohl diese Befunde eine Wiederprufung durch weitere Untersuchungen notig haben, scheinen sie gegenwartig darauf hinzuweisen, dass mit zunehmendem Alter eine Zunahme an Ehrgeiz und in Bezug auf Selbstkritik oder Gewissenhaftigkeit einhergeht. Diese Einwirkungen fuhren alle zu einer gewissen Empfindlichkeit dem Miserfolg gegen uber und zu Versuchen, die eigene Ehre zu retten. Dieser Schluss stimmt mit gewissen Befunden von J. Piaget uber die Entwicklung der Vorgange der Selbst-kritik im Denken des Kindes uberein.

ROSENZWEIG

DAY AND NIGHT SLEEP IN A GROUP OF YOUNG ORPHANAGE CHILDREN*[1]

From the Iowa Child Welfare Research Station

MARY A. WAGNER

Preschools operating on the all-day program make the afternoon nap an important phase of their routine This practice is followed in spite of the fact that little or no scientific information is available regarding the number of children that should be allotted to the sleeping room, the procedures that are best adapted to conducting this period, the real need for it on the part of the children, and the relationships it may have to subsequent night sleep

This study was designed to obtain reliable information regarding the day and night sleep of a group of young children as a first step toward understanding the probable educational significance of the afternoon nap program in nursery schools.

The specific aspects of the investigation have been limited to

1 The formulation of reliable criteria for judging the sleeping state in children

2 The development of an observational measure for restlessness during the presleep period

3. Determining the mean length of time required to go to sleep (*a*) in the afternoon, and (*b*) at night for the group and for individual children

4. Finding the mean duration and deviation of (*a*) afternoon sleep, and (*b*) night sleep for individuals and the group

5 Ascertaining the relationship of (*a*) the duration of day sleep to night sleep, (*b*) the duration of day sleep to length of time going to sleep, and (*c*) length of time going to sleep in the afternoon to length of time going to sleep at night

*Recommended by George D Stoddard, accepted for publication by Carl Murchison of the Editorial Board, and received in the Editorial Office, October 3, 1932

[1]This study was directed at the Iowa Child Welfare Research Station by Dr. Beth L Wellman

6 Determining the correlation of sleep with (*a*) chronological age, and (*b*) mental age

7 Obtaining a restlessness score for each child during the day and night presleep period.

8 Determining the relationship of (*a*) mean day restlessness score to mean night restlessness score, and (*b*) mean restlessness score to time going to sleep for both afternoon and night.

Preliminary Observations

The initial observations for this study were made upon the children enrolled in Second Group of the Iowa Child Welfare Research Station preschool laboratories during the school year 1931-1932 This group was composed of 20 children, 11 boys and 9 girls, ranging in age from 2 years, 9 months, 25 days to 3 years, 11 months, 20 days at the beginning of the observational period

For a period of three weeks, the writer made daily observations in the nap room throughout the whole of the period. The time was spent in working out observational criteria for judging when a child was asleep or awake, devising means for collecting the data, and recording the kinds of restlessness prevalent during the presleep period Later observations in the Second Group were devoted to establishing reliability on these items

In addition to the regular equipment of the sleeping porch, the materials used included blanks for recording the observations and two regulated Westclox Dax watches set daily at the beginning of the period.

Criteria for Sleep Although the state of sleep is accompanied by a number of physiological changes in posture, blood pressure, pulse rate, muscle tonus, and the nature of activity, there are three observable characteristics present when the child is said to be asleep These are. (1) a cessation of gross bodily activity, (2) eyes closed, and (3) appearance of even, regularly rhythmic breathing The simultaneous presence of these three conditions in the children became, therefore, the accepted criteria of sleep as used in this study It would be possible to ascertain the validity of these criteria—cessation of gross movement by the stabilimeter technique, eyes closed by reliable observation, and change in type of breathing by means of a pneumograph

Collection of Data In a systematic tour of the sleeping porch, the writer recorded the presence or absence of these three criteria for

each child once during every five-minute interval throughout the nap period The records were kept in rotation, i.e, each five-minute period began by observation of the child in bed 1, followed by child in bed 2, etc The notations were placed in columns headed with the time as of the beginning of the period—1·40, 1 45, 1.50, etc. All records were made within this time interval

Measure of Restlessness. Descriptive notations regarding behavior during the presleep period contained three very general but distinct types of activity These could be designated by the following categories

A. Cessation of gross bodily movement—the still, relaxed state characteristic of sleep

B Slight movement of arms, legs, head, or body without the accompaniment of noise.

C Actively moving about—shaking the bed or screen, or making noise that is disturbing or potentially disturbing to others or both When the activities are thus classified and *A* is given a score of 0, *B* a score of 1, and *C* a score of 2, it becomes possible to obtain a score representing the child's activity during the presleep period of any day or series of days This cumulative numerical value was designated as the restlessness score.

Reliability of Observations For each of the three criteria of sleep systematic, simultaneous five-minute-interval observations were made by two observers. Reliabilities based upon 120 judgments of each item were as follows·

M	(cessation of gross movement)	95 00
E	(eyes closed)	98 33
B	(regularity in breathing)	100 00

Disagreements on *M* and *E* are quite probably due to the short intervals during which these may be present in the presleep period The change in breathing, *B*, comes as the final stage of going to sleep and is maintained throughout the period of sleep

The restlessness score involved checking the child's activity in one of three categories· 0—cessation of gross activity, 1—slight movements, 2—violent or disturbing activity The checks were made by two observers observing simultaneously and were recorded for the same five-minute intervals as were the observations on criteria of sleep. The reliabilty based upon 120 judgments of child activity was 87 5

In computing the reliability on time going to sleep and time awaking, the teachers' records of these items were used. They did not make a systematic tour of the sleeping porch in five-minute intervals, but attempted to be aware of the whole room all of the time in order to give properly concentrated attention to those who needed help in learning to lie still. The records kept by them are made in figures to the minute, i.e., 12·47, 1·18, 2·31, etc., for each child.

When the two sets of records were compared for an identical period (three weeks), the exact minute scores of the teachers were put into five-minute intervals as used by the writer. Time figures which were at the extremes of the interval (and could have been placed in either of two categories) were counted as disagreements in judgment. The percentage of agreement, within the five-minute interval, as based upon 194 child observations was as follows:

Child asleep	97.42
Child awake	98.93

Presleep Activity and Duration of Sleep. Since one of the ultimate purposes of the main study was to obtain insight into possible reasons for the long time spent in presleep activity during the afternoon, a tabulation of figures on this item for the children in several nursery schools is of interest. Some of the reported means for time (in minutes) required to go to sleep and duration of nap are as follows.

Nursery School	Records	Children	Mean time: Going to sleep	Mean time: Duration of sleep
Washington Child Research Center	School year	22	38.3	89
Vassar	Semester	27	38.0	74
Toronto	School year	13		65
Minnesota	School year	56	34.8	79
Iowa Child Welfare Research Station	1929-1930	15	40.0	89
	1930-1931	19	42.1	
	Fall, 1931	20	41.3	72

Main Study

Subjects. The subjects for the observations of the main study were 42 boys in Cottage 1 of the Iowa Soldiers' Orphans' Home. They ranged in age from 2 years, 1 month, 17 days to 5 years, 8

months, 23 days Of this group there were 34 who were not absent from the daily observation period Absences of the remaining 8 were due either to illness, removal to the metabolism ward of the Iowa Child Welfare Research Station, or adoption during the period For the 34 always present the age groups were as follows:

Children	Age, range
6	25 to 36 months
15	37 to 48 months
9	49 to 60 months
4	61 to 72 months

Daily observations for the 30-day period included: (1) waking time in the morning beginning at 4.15 A.M., (2) the whole of the afternoon sleep period beginning at 12:45 P.M.; (3) time of going to sleep at night (usually lasting from 5 45 to 8·00 o'clock), and (4) restlessness during the presleep period both afternoon and night. Observations on each child were made at five-minute intervals

RESULTS

For the Group

Day The mean and standard deviation of time going to sleep and duration of sleep (both day and night) for the group by days is shown in Table 1 The range for time going to sleep in the afternoon is from 16.0 to 30 0 minutes, standard deviations range from 7.6 to 21 4 minutes The mean length of time going to sleep for this group during the observation period was 24.14 minutes with a standard deviation of 3.93 minutes. This mean is 10 7 minutes shorter than the lowest mean (34.8 minutes, standard deviation 20 7 minutes) reported for nursery schools It is certain that there is a true difference between these means (ratio of difference to standard deviation of the difference is 3 5)

The duration of afternoon sleep for the group ranged from 61 8 to 126 7 minutes, with standard deviations from 10 5 to 43 7 minutes (Table 1) On only three days did every child present go to sleep, the number of children not sleeping ranged from zero to seven with three as the median number The mean duration of afternoon sleep for the group was 97.59 minutes with a standard deviation of 23 20 minutes This is 8 59 minutes more than the longest time reported (89 minutes, standard deviation 19 minutes)

TABLE 1

MEAN AND STANDARD DEVIATION OF TIME GOING AND DURATION OF DAY AND NIGHT SLEEP IN MINUTES FOR THE GROUP BY DAYS

			Day				Night			
			Time going to sleep		Duration of sleep		Time going to sleep		Duration of sleep	
Day	Children present	Children not taking nap	Mean	S D	Mean	S D	Mean	S. D	Mean	S D
1	36	0	00.0	0.0	00.0	00.0	51.8	31.4	598.1	38.7
2	36	36	00.0	0.0	00.0	00.0	43.9	29.7	579.0	29.7
3	37	0	16.0	7.6	121.0	17.8	91.3	24.9	551.9	26.7
4	39	2	19.9	11.0	94.8	30.3	80.7	31.4	580.4	38.1
5	42	0	17.2	8.6	121.3	16.0	70.1	29.5	601.1	32.6
6	42	6	21.1	13.4	78.3	35.0	85.2	31.5	571.4	28.3
7	42	2	24.3	12.8	100.0	27.4	65.7	32.9	581.6	30.1
8	42	1	22.2	13.3	120.6	22.6	96.9	40.2	545.0	41.7
9	42	3	22.7	15.8	105.9	36.8	105.5	38.8	537.6	41.5
10	41	2	26.2	14.2	106.0	29.3	88.4	34.7	572.1	33.1
11	41	3	24.5	12.7	109.9	33.2	100.6	38.5	553.3	31.4
12	41	3	22.3	13.7	94.3	32.0	68.5	43.0	591.5	45.4
13	40	3	24.1	15.2	111.5	34.3	103.3	33.5	563.2	31.2
14	39	1	19.1	14.8	122.2	26.5	102.8	32.0	554.2	30.8
15	39	1	24.7	11.1	98.6	36.3	100.6	33.4	556.0	30.6
16	39	1	20.9	19.2	114.5	28.9	99.4	33.6	571.4	34.7
17	39	4	27.1	21.4	96.0	36.6	82.2	30.8	573.5	30.6
18	39	1	30.0	14.7	104.5	23.1	88.4	29.5	579.9	26.8
19	39	2	16.5	8.2	103.5	31.0	90.7	26.9	563.5	31.6
20	39	3	18.8	10.3	99.1	30.5	93.3	32.2	576.3	33.1
21	38	5	21.7	9.9	92.3	34.0	69.8	22.6	579.8	26.6
22	37	7	28.7	9.5	61.8	30.6	61.8	29.0	588.3	26.6
23	37	3	19.9	8.3	89.4	36.4	74.5	28.3	579.6	26.7
24	37	1	22.5	11.7	91.3	25.5	79.6	29.4	578.6	30.0
25	37	0	19.5	8.8	126.7	10.5	88.1	26.8	574.8	27.3
26	36	7	26.9	9.3	81.4	43.7	118.6	45.7	558.1	44.2
27	37	3	22.5	14.1	94.0	31.9	114.0	36.4	559.4	37.1
28	37	3	28.0	8.2	108.0	31.3	111.0	41.0	557.2	39.0
29	37	2	16.4	8.7	90.7	36.0	63.9	33.1	597.8	34.9
30	37	3	20.2	10.7	100.7	33.7	108.7	52.6	548.3	44.1

for nursery schools. There are 97 chances in 100 that this is a true difference (ratio of difference to standard deviation of the difference is 1 9).

Night. The means for time going to sleep at night (based on daily group means) ranged from 43.9 to 118 6 minutes with standard deviations from 22 6 to 52.6 minutes The lowest mean time going to sleep was for the night when the afternoon nap was missed because of the Sunshine Ride, i e, the group went to sleep more quickly in the evening when deprived of a nap. The mean time of going to sleep at night for this group was 87 93 minutes with a standard deviation of 16.65 minutes This is more than three and one-half times as long as the mean for going to sleep in the afternoon. The difference is probably due to the long period of time awake before the nap (eight hours) as compared to the short interval of time awake between the nap and bedtime (two and one-half to three hours).

The duration of night sleep ranged from 537.6 minutes to 601 1 minutes with standard deviations of 26 6 to 45 4 minutes. The mean amount of night sleep for the group during the observation period was 569.79 minutes with a standard deviation of 13 65 minutes.

Although the group means cover much of the individual variability within this group, they give a clear picture of the general conditions of daily sleep in an institutional regime. The relationship of the duration of day and night sleep for the group is expressed in the Pearsonian correlation -329 ± 11 This group shows some tendency for long afternoon sleep to be followed by short night sleep

The correlation of the duration of day sleep and the length of time required to go to sleep at night is $+.553 \pm .09$, i.e, for this group a long afternoon sleep has a tendency to be followed by a long period of remaining awake in the evening There is a negligible correlation, $.172 \pm .13$, for time going to sleep in the afternoon and time going to sleep at night

For Individuals

Day. Table 2 shows the mean and standard deviation of time going to sleep and duration of sleep for individuals in the afternoon and at night. Data are included for the 34 children who were present during the entire observation.

TABLE 2

MEAN AND STANDARD DEVIATION OF TIME GOING AND DURATION OF DAY AND NIGHT SLEEP IN MINUTES FOR INDIVIDUALS OVER A THIRTY-DAY PERIOD

			Day				Night			
			Time going to sleep		Duration of sleep		Time going to sleep		Duration of sleep	
Child	Age, months	Days without nap	Mean	S D	Mean	S D.	Mean	S D	Mean	S D
M34	26	1	8.9	6.7	109.3	35.3	80.2	21.4	532.2	21.7
M31	29	1	13.4	8.7	113.1	24.6	69.8	28.5	593.5	25.2
M32	33	3	22.7	11.1	93.4	30.9	95.5	38.9	566.8	39.7
M33	34	2	27.9	7.4	71.6	25.7	50.2	22.4	608.8	24.4
M1	36	1	18.5	5.3	115.9	20.3	63.2	29.1	598.2	29.6
M30	36	1	23.4	10.7	110.2	18.6	84.8	30.1	574.2	27.3
M29	38	2	18.4	6.7	101.6	33.5	90.2	29.1	572.8	33.1
M28	39	1	9.0	4.5	114.5	20.9	41.6	25.8	601.6	28.8
M27	40	4	28.0	18.5	88.1	38.3	117.5	45.3	543.5	38.0
M13	40	2	17.5	7.7	109.5	29.1	88.5	40.6	569.8	36.1
M26	40	1	13.8	6.2	118.4	20.4	64.2	37.8	591.2	36.6
M12	40	1	16.0	12.7	110.0	29.2	89.8	26.7	571.8	26.7
M14	41	1	9.7	5.3	116.2	25.1	63.8	20.3	597.5	28.8
M11	43	2	26.7	20.5	98.6	39.0	100.5	32.7	556.8	38.9
M10	43	2	24.7	9.4	108.6	32.1	92.8	30.2	563.2	31.2
M9	45	1	25.4	10.5	104.8	33.1	103.5	36.7	558.8	35.1
M2	45	2	26.0	13.5	102.8	32.4	68.6	22.9	589.0	34.7
M3	46	20	24.3	10.9	29.8	42.3	60.6	39.2	595.2	39.9
M23	48	2	19.8	8.5	101.1	33.0	89.5	41.0	569.8	41.2
M24	48	2	21.8	10.0	96.2	30.0	83.8	29.2	572.8	29.4
M25	48	1	20.7	7.5	109.0	28.7	80.2	32.1	573.8	28.8
M22	50	2	37.5	13.8	77.5	32.3	106.8	40.0	552.2	36.6
M21	52	1	10.0	3.9	121.8	17.5	69.5	24.2	593.8	25.3
M4	53	4	27.4	10.1	97.6	40.5	94.5	30.0	564.2	39.8
M7	56	2	32.5	14.0	95.6	32.2	108.6	27.9	554.2	25.4
M8	56	2	19.0	9.5	110.0	31.4	96.8	33.3	559.8	33.6
M6	57	3	31.0	14.2	90.9	34.4	58.8	24.0	597.2	26.8
M16	58	4	24.0	8.7	74.2	35.2	124.2	29.0	534.8	30.1
M18	59	9	28.3	16.5	77.1	48.9	74.8	42.1	569.5	46.5
M5	60	8	34.5	16.8	74.9	47.3	114.2	37.0	546.0	41.6
M15	62	6	34.0	14.1	79.7	42.6	116.5	50.6	540.5	43.8
M17	62	1	31.0	15.0	102.8	24.2	104.8	31.9	556.5	28.7
M20	62	3	25.0	12.5	93.5	36.9	65.2	26.7	595.2	25.4
M19	69	7	33.2	13.8	69.7	39.8	83.2	31.4	572.8	32.9

Twelve children went to sleep every afternoon they were in the dormitory. These 12 are spread throughout the entire age range, but group themselves in a manner which makes the percentages of children who slept every day as follows:

Age range, months	Children	Percentage sleeping daily
25 to 36	6	66.6
37 to 48	15	40.0
49 to 60	9	11.1
61 to 72	4	25.0

The greatest number of days without nap for any child was 20, the median was 2. The majority of the higher figures for days without nap comes in the upper age levels.

One is impressed at once with the extreme variability in this group. The range of mean time going to sleep is from 8.9 minutes to 37.5 minutes with 24 minutes as the median mean figure. This is a wider range than the daily group means (Table 1). Standard deviations are from 3.9 to 20.5 minutes.

The range of the means for the duration of afternoon sleep is from 29.8 to 121.8 minutes. The child having the lowest mean is the child who slept less than one-third of the days present in the dormitory. The highest mean comes in the four-year-old age level.

Night. The means for time going to sleep at night range from 41.6 minutes to 124.2 minutes with standard deviations ranging from 20.3 to 50.6 minutes. The mean duration of night sleep is from 534.8 to 608.8 minutes with standard deviations ranging from 21.7 to 46.5 minutes. The rising-bell in the morning terminated the night sleep and may have operated to produce relatively lower standard deviations (considering the mean) for length of night sleep as compared to standard deviations for duration of day sleep. It was interesting to note the effect of the later rising-bell on Sundays.

Sunday	Children	Sleeping after 5.05 A.M.	Sleeping after 5.20 A.M.	Latest sleep	
First	42	27	7	5:40	(2 cases)
Second	39	14	4	5:55	(1 case)
Third	37	6	4	5:40	(1 case)

In general, these children were accustomed to getting awake about five o'clock and continued to do so even though the bell did not ring

Duration of Sleep for the Twenty-Four-Hour Period

The mean amount of total sleep during 24 hours for all individuals present throughout the observation is given in Table 3 When the amounts are stated in hours and the children grouped in yearly age levels, the results are as follows

Age range, months	Children	Range of mean total sleep: Hours	Minutes		Hours	Minutes
25 to 36	6	11	0	to	11	54
37 to 48	15	10	25	to	11	56
49 to 60	9	10	9	to	11	55
61 to 72	4	10	20	to	11	22

The means are all lower than the amounts recommended in the literature (4) The figures given in the literature are probably based upon reports of time spent in bed rather than upon reports of actual amount of sleep taken and are, therefore, much higher than records of actual sleeping time

The means for the four- to six-year-old children compare favorably with the results reported by Foster, Goodenough, and Anderson (1) The amounts for the younger children are lower than the Minnesota figures and the Reese (3) figures

Relationship of Day and Night Sleep

The product-moment correlation coefficients for the amount of day and night sleep for individual (34) children over the 30 days of observation are shown in Table 3. These range from + 597 ± 08 to — 915 ± 02 With two exceptions these are negative correlations, and in 21 cases they are statistically significant (2, p 170) For the majority of these children, this indicates a tendency for the longer nap to be followed by the shorter night sleep, or the shorter afternoon sleep by the longer sleep at night

There is one positive correlation, + 597 ± 08, for a boy whose chronological age was 41 months but with a mental age of only 21 months For this individual, the greater the amount of sleep in the afternoon the greater the amount at night

The higher negative correlations tend to appear with greater fre-

TABLE 3

MEAN AMOUNT OF TOTAL SLEEP IN MINUTES AND CORRELATIONS (WITH PROBABLE ERRORS) OF DAY AND NIGHT SLEEP FOR INDIVIDUALS OVER A THIRTY-DAY PERIOD

Child	Age, months Chronological	Mental	Mean amount of total sleep	Correlation between day and night sleep r PE
M34	26	14	691.5	—281± 11
M31	29	22	706 6	—248± 12
M32	33	30	660 2	—749± 05
M33	34	32	680 4	—111± 12
M1	36	36	714 1	—071± 13
M30	36	49	684 4	—478± 09
M29	38	23	674 4	—407± 10
M28	39	32	716 1	—242± 13
M27	40	32	631.6	—489± 09
M13	40	33	679 3	+ 053± 12
M26	40	20	709 6	—.114± 12
M12	40	28	681 8	— 347± 11
M14	41	21	713 7	+ 597± 08
M11	43	35	655 4	— 535± 09
M10	43	31	671 5	—.481± 09
M9	45	50	663 6	— 643± 07
M2	45	33	691 8	—266± 11
M3	46		625 0	—795± 04
M23	48	31	670 9	— 502± 09
M24	48	43	669 0	—.458± 10
M25	48	38	682 8	—300± 11
M22	50	44	629.7	—370± 11
M21	52		715 6	—915± 02
M4	53	52	661 8	—616± 08
M7	56	45	649 8	—622± 08
M8	56	42	659 8	—836± 04
M6	57	46	688 1	—681± 07
M16	58	55	609 0	—439± 10
M18	59	53	646 6	—477± 09
M5	60	67	620.9	—.566± 08
M15	62	58	620.2	—780± 05
M17	62	57	659 3	—257± 11
M20	62	44	688 7	—.029± 12
M19	69	57	642 5	—545± 09

quency after the 48-month chronological age level. These individual correlations substantiate and lend emphasis to the correlation of relationship of day and night sleep as based upon the daily group means. This figure is —.329±.11

The relationship between day and night sleep raises the question as to whether the child takes a constant mean amount of sleep over

a 24-hour period. A complete analysis of these data has not been made by the writer. The child representing the upper quartile (M8, 56 months) has a range in total amount of sleep from 595 to 740 minutes with a mean of 659.8 minutes. Total sleep for M13 (40 months), representing the lower quartile age group, ranges from 525 to 745 minutes with a mean of 679 3 minutes In the first case, M8, there is maintained a fairly constant amount of total sleep, and the correlation for the day and night relationship is — 836 For M13, however, the rhythm of total amount is varied, and the correlation for day and night duration is negligible being only + 53.

Correlation of Sleep and Age

Chronological Age. The chronological age range is from 26 to 69 months. The Pearsonian correlation of total sleep and chronological age, based upon the amounts for 34 children, is —.445±.10, showing a tendency for less sleep at the older age levels. When mental age is factored out, the partial correlation is changed to + 386 ±.11, indicating a slight tendency for more sleep at the older age levels.

Mental Age. The mental age range is from 14 to 67 months. The Pearsonian correlation of total sleep and mental age for 32 of these children (two were unable to be tested due to defective hearing) is —.729±.05 When chronological age is factored out, the partial correlation (—712± 06) is practically unchanged in its significance This high correlation indicates that the decrease in total amount of sleep depends to a greater extent upon the increase in mental age than the increase in chronological age

Restlessness Scores

The cumulative restlessness score was determined for each child during the day and night presleep period These were totaled for the 30 days of observation and a mean score obtained for each of 34 children Arranged in ascending chronological age order, the mean scores for both day and night are as shown in Table 4

The mean scores for individuals range from 08 to 7 56 in the afternoon and from 2.35 to 13 96 at night With one exception, M3, the night scores are higher than the day scores. M3 is the child who slept in the afternoon less than one-third of the time.

The mean restlessness scores by days range from 85 to 4.06 in the afternoon and from 4 06 to 12 80 at night. The relationship

between day and night restlessness is very slight—correlation of +.155± 12. The correlation for daily mean restlessness score and length of time going to sleep is + 522±.09 for day and + 658± 07 for night. These correlations indicate that there is a tendency for the longer presleep period, both day and night, to be accompanied by more restlessness

Sleeping Alone Versus Sleeping with Another Child

Of the 34 children present throughout the entire observation, 8 always slept with another child, 15 always slept alone, and 11 some-

TABLE 4

Child	Age, months	Restlessness score Day	Night
M31	29	.75	12 21
M34	26	32	2 35
M32	33	1 64	7 72
M33	34	3 39	5.14
M30	36	2 04	6 60
M1	36	36	3 72
M29	38	1 75	8 60
M28	39	15	2 85
M27	40	5 42	13 57
M12	40	1 28	7 36
M13	40	1 86	11 50
M26	40	.43	3 43
M14	41	28	4 43
M11	43	4 17	13 68
M10	43	2 41	10 29
M2	45	2 45	5 15
M9	45	2 17	8 18
M3	46	7.56	3 44
M25	48	1 85	7 11
M23	48	1 62	8 10
M24	48	2 93	13 96
M22	50	2 79	8 71
M21	52	08	6 67
M4	53	3 67	4 71
M7	56	2 48	7 47
M8	56	2 03	13 85
M6	57	4 07	4 78
M16	58	1.07	5 67
M18	59	4 43	7 03
M5	60	4 48	9 28
M20	62	2 69	6 43
M15	62	3 55	10 17
M17	62	2 24	12 75
M19	69	2 79	5 32

TABLE 5

A Comparison of Mean Time Going to Sleep and Duration of Sleep in Minutes, and Restlessness Score of Day and Night Sleep for Individuals Sleeping Alone and with Another Child

Child	Age, months	Days	Day: Time going to sleep	Day: Duration of sleep	Day: Restlessness score	Night: Time going to sleep	Night: Duration of sleep	Night: Restlessness score
				When sleeping alone				
M30	36	14	24.7	106.7	1.9	90.2	571.7	6.6
M29	38	13	19.6	85.2	2.4	83.8	571.2	9.7
M13	40	14	18.2	103.2	1.4	84.5	577.3	10.4
M26	40	16	15.0	113.9	.4	62.3	591.7	2.2
M11	43	16	23.2	91.4	3.4	92.7	562.8	4.5
M10	43	17	20.7	100.4	2.8	100.6	564.0	11.1
M3	46	18	18.8	26.7	6.6	64.6	595.0	3.7
M23	48	14	21.9	97.5	2.3	82.4	572.4	6.8
M16	58	5	28.8	109.9	3.8	126.5	514.5	3.2
M17	62	12	26.8	95.1	2.3	92.2	568.4	10.5
M19	69	18	32.9	70.6	3.6	81.4	580.2	6.2
				When sleeping with another child				
M30	36	14	22.2	106.5	2.4	80.2	576.3	8.0
M29	38	15	17.0	117.6	1.2	96.5	567.8	8.3
M13	40	14	17.2	114.5	2.3	92.0	563.2	12.0
M26	40	12	12.1	135.2	.4	65.4	591.2	5.5
M11	43	13	9.2	107.6	.9	103.7	569.1	13.9
M10	43	12	17.9	120.2	1.9	88.7	562.0	9.2
M3	46	9	31.7	33.4	9.3	90.1	595.6	2.9
M23	48	15	17.9	103.9	1.0	92.0	567.0	9.9
M16	58	24	23.1	75.4	1.3	61.7	572.2	6.2
M17	62	17	32.1	108.0	2.6	114.5	548.6	9.5
M19	69	11	30.7	95.4	1.6	95.4	559.9	3.8

times slept alone and sometimes with another child. In order to compare the sleep habits of a child when sleeping alone and when sleeping with another child, the data for these 11 children were analyzed.

Table 5 gives the mean time going to sleep, the duration of sleep in minutes, and the mean restlessness score both day and night for 11 children (*a*) when sleeping alone and (*b*) when sleeping with another child.

This table indicates that in nine cases it required longer to go to sleep in the afternoon when sleeping alone, but in eight cases it required longer to go to sleep at night when with another child. In all but one case the duration of afternoon sleep is greater when sleeping with another child; at night the greater duration in seven cases is when sleeping alone. The higher restlessness scores are about equally distributed between sleeping alone and sleeping with another child.

In order to determine whether there were significant differences between these means, the items for each child were put into 12 distributions, 6 when sleeping alone and 6 when sleeping with another child. Both day and night distributions were made for (1) time going to sleep, (2) duration of sleep, and (3) restlessness score. The means of the six distributions for items when sleeping alone are based upon 157 child observations, for sleeping with another child on 156 child observations. The mean differences are shown in Table 6.

The greatest differences are for time going to sleep and duration of sleep at night, each case favoring the times when sleeping alone.

TABLE 6

Item		Mean score Alone	With another child	Mean differences
	Day			
Time going to sleep		23.3	22.6	.7
Duration of sleep		103.2	107.7	4.5
Restlessness score		2.7	2.4	.3
	Night			
Time going to sleep		84.6	95.3	10.7
Duration of sleep		574.9	561.8	13.1
Restlessness score		7.8	7.2	.6

The significance of the difference for all of the means is as follows (Table 7):

TABLE 7

Item		Probable error of difference	Ratio of difference to probable error of difference
	Day		
Time going to sleep		1.37	.46
Duration of sleep		2.22	2.03
Restlessness score		.28	.93
	Night		
Time going to sleep		2.81	3.82
Duration of sleep		2.78	4.71
Restlessness score		.50	1.37

There are 99.5 chances in 100 that there is a true difference in the time going to sleep at night, i.e., children go to sleep more quickly at night when sleeping alone. It is practically certain that children sleep longer at night when they have a bed alone.

There are 91 chances in 100 that there is a true difference in the duration of day sleep in favor of sleeping with another child, i.e., these children tend to sleep longer in the afternoon when they share a bed. In other words, there appears to be some attempt at making up the loss of night sleep during the nap.

References

1. Foster, J. C., Goodenough, F. L., Anderson, J. E. The sleep of young children. *J. Genet. Psychol.*, 1928, 35, 201-218.
2. Garrett, H. E. Statistics in psychology and education. New York: Longmans, Green, 1926. Pp. xii+317.
3. Reese, M. A study of the effects of daylight saving time upon the sleep of young children. *Child Develop.*, 1932, 3, 86-89.
4. Rowntree, J. I. A study of sleep. Unpublished investigation, Iowa Child Welfare Res. Station.

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LE SOMMEIL PENDANT LA NUIT ET PENDANT LA JOURNÉE CHEZ UN GROUPE DE JEUNES ENFANTS D'UN ORPHELINAT

(Resumé)

On a observé systématiquement pendant une période de trente jours le sommeil pendant la journee et pendant la nuit de quarante-cinq garçons d'un orphelinat, âgés de deux ans, un mois, dix-sept jours à cinq ans, huit mois, vingt-trois jours On a obtenu des donnees sur le temps passé a s'endormir, la durée du sommeil, et l'agitation des periodes avant le sommeil On rapporte les resultats suivants

1 Le temps moyen passé à s'endormir à l'après-midi a été de 24,1 minutes pour le groupe, écart étalon, de 3,93 Pour les individus la variation du temps moyen passé à s'endormir à l'apres-midi a eté de 8,9 à 37,5 minutes, les écarts étalons variant de 3,9 à 20,5 Le temps moyen passé à s'endormir la nuit a été de 87,9, écart étalon, de 16,6 minutes La variation du temps moyen pour les individus a été de 41,6 à 124,2 minutes avec des écarts étalons de 20,3 à 50,6 minutes

2 La durée moyenne du sommeil à l'après-midi a ete de 97,6 minutes pour le groupe, écart étalon, de 23,2 minutes Pour les individus la variation a ete de 29,8 a 121,8 minutes avec des écarts étalons de 17,5 à 48,9 minutes La durée moyenne du sommeil pendant la nuit pour les groupes a été de 569,8 minutes, ecart étalon, de 13 7, Pour les individus la variation a eté de 534,8 à 608,8 minutes avec des écarts étalons de 21,7 à 46,5 minutes

3. Les correlations pour la durée du sommeil pendant la journée et pendant la nuit ont varié de $+0{,}60\pm0{,}08$ à $+0{,}02$, lesquelles, à l'exception de deux, ont été négatives, les plus élevées étant au niveau supérieur d'âge La corrélation entre le sommeil total pendant les périodes de vingt-quatre heures et l'âge chronologique, sans égard de l'âge mental, a été de $+0{,}39 \pm0{,}11$, entre le sommeil total et l'âge mental, sans égard de l'âge chronologique, de $+0{,}71\pm0{,}06$ Une corrélation de $+{,}52\pm0{,}09$ pour la journée et de $+0{,}66\pm0{,}07$ pour la nuit s'est montree le résultat de l'agitation et le temps passé à s'endormir

4 Les enfants ont tendu à s'endormir plus vite et à dormir plus longtemps la nuit quand ils ont dormi seuls que quand ils ont dormi avec un autre enfant

WAGNER

TAG- UND NACHTSCHLAF EINER GRUPPE JUGER WAISENHAUSKINDER

(Referat)

Der Tag- und Nachtschlaf von 45 Waisenknaben, deren Alter sich zwischen 2 Jahren, 1 Monat, 17 Tagen, und 5 Jahren, 8 Monaten, 23 Tagen erstreckte, wurden wahrend 30 Tagen systematisch beobachtet Es wurden Befunde erhalten uber die zum Einschlafen verwendete Zeit, die Dauer des Schlafes, und die Unruhe wahrend der dem Schlaf vorausgehenden Perioden Es werden folgende Befunde gemeldet

1. Die mittlere Nachmittags zum Einschlafen verwendete Zeit [mean time of going to sleep] betrug 24.1 Minuten, Normalabweichung 3 93 Bei Individuen betrug die mittlere Zeitverwand beim Einschlafen 8 9 bis 37 5

Minuten, wobei die Normalabweichungen zwischen 3 9 und 20 5 schwankten Nachts betrug der mittlere Zeitverwand beim Einschlafen 87 9, Normalabweichung 16 6 Minuten Der mittlere Zeitverwand bei den Individuen schwankte zwischen 41 6 und 124 2 Minuten, wobei die Normalabweichungen 20 3 bis 50 4 Minuten betrugen

2. Die mittlere Dauer des Nachmitatgsschlafes der Gruppe betrug 97 6 Minuten, Normalabweichung, 23 2 Minuten Bei den Individuen schwankte die mittlere Dauer zwischen 29 8 und 121 8 Minuten, wobei die Normalabweichungen zwischen 17 5 und 48 9 lagen *Die mittlere Dauer des Nachtschlafes* betrug 569 8 Minuten, Normalabweichung 13 7 Bei Individuen schwankte der Nachtschlaf zwischen 534 8 und 608 8 Minuten, wobei die Normalabweichungen zwischen 21 7 und 46 5 Minuten lagen

3 Korrelationen zwischen der Dauer des Tag- und der des Nachtschlafes schwankten zwischen $+ 60 \pm 08$ und -92 ± 02 Diese Korrelationen waren mit zwei Ausnahmen negativ, und die hochsten fanden sich in der oberen Altersgruppe Die Korrelation der Summe des Schlafes wahrend der 24 Stunden langen *Perioden mit dem chronologischen Alter*, unter Ausschliessung des geistigen Alters [partialling out mental age], betrug $+ 39 \pm 11$ Die Korrelation der Summe des Schlafes mit dem geistigen Alter betrug, unter Ausschliessung des chronologischen Alters, -71 ± 06 Man fand eine Korrelation von $+ 52 \pm 09$ fur den Tag und $+ 66 \pm 07$ fur die Nacht, *zwischen dem Grad der Unruhe* [restlessness score] und dem Zeitverwand beim Einschlafen

4. Im grossen Ganzen schliefen die Kinder schneller ein und schliefen Nachts langer, wenn sie allein schliefen als wenn sie mit einem zweiten Kinde schliefen

WAGNER

SHORT ARTICLES AND NOTES

THE PREDICTION OF THE INTELLIGENCE QUOTIENTS OF YOUNGER SIBLINGS[1]

R. L. JENKINS

Numerous investigators have used the sibling correlation as a measure of the effect of heredity. The correlation between the intelligence of siblings, like the correlations between anthropometic measurements, has commonly been determined at about .5 The eugenic importance of the sibling correlation may perhaps be illustrated by the following family

All the children of the ——— family were examined at the Institute for Juvenile Research The mother was confined in a state hospital with a diagnosis of dementia praecox, paranoid type She was an undersized woman in poor physical condition and had always been counted as simple. Previous to her marriage she had an illegitimate daughter of whom very little is known. She married a man regarded as simple and easy-going and gave birth to eight children before she was 34 Her husband, who was probably feebleminded, died of tuberculosis When Mrs ——— became psychotic all of her legitimate children were examined at the Institute for Juvenile Research, and their intelligences were determined as follows:

1. Boy, chronological age 16 years 5 months, mental age 5 years 5 months, intelligence quotient 38, classification imbecile.
2. Girl, chronological age 14 years 0 months, mental age 5 years 10 months, intelligence quotient 42, classification imbecile
3. Boy, chronological age 12 years 0 months, mental age 7 years 0 months, intelligence quotient 58, classification moron.
4. Girl, chronological age 10 years 0 months, mental age 5 years 2 months, intelligence quotient 53, classification moron.
5. Boy, chronological age 8 years 2 months, mental age 4 years 1 month, intelligence quotient 50, classification moron

[1]Studies from the Illinois Institute for Juvenile Research, Series C, No 225.

6. Girl, chronological age 6 years 8 months, mental age 4 years 0 months, intelligence quotient 67, classification moron
7. Boy, chronological age 4 years 8 months, mental age 2 years 4 months, intelligence quotient 67, classification moron
8. Boy, chronological age 2 years 11 months, mental age 1 year 3 months, intelligence quotient 43, classification, probably imbecile.

The succession of feebleminded children here described will probably increase the reader's expectation of more defectives as he reads down the family list. A question of some practical as well as scientific importance is: To what degree is this increasingly pessimistic expectation justified? To what degree is it possible to refine the prediction of the intelligence level of later siblings by the consideration of more than one of the earlier siblings?

Material for this study was selected from data on 10,000 children routinely examined at the Illinois Institute for Juvenile Research The intelligence quotients used were based on individual Stanford-Binet examinations

Children are usually referred to the Institute for Juvenile Research because of behavior problems or because of retardation. A considerable fraction of these children are of defective intelligence and many others are dull This results in a relatively low mean intelligence quotient for the Institute population

While the question of method of selection of material is all important in any discussion of the correlation between siblings, and while the Institute cases are obviously selected in good part for low intelligence level, the similarity in results between this and other studies would make it appear that the trends in the relation between siblings present here are not different from those in a more random sampling of the population. Regardless of the comparability of results in regard to degree of correlation, the evidence of degree of increase of the correlation through adding other siblings in a multiple correlation procedure should be valid for a generalization

Data were obtained upon children in 132 families, each of which had three children examined at the Institute. The mean intelligence of the oldest,[3] middle, and youngest of these three respectively was 78±1, 84±1, and 85±1 This shift is in accord with the tendency of the later-born

[3]Oldest, middle, and youngest as used here refer to the oldest, middle, and youngest of those children examined at the Institute They may be the second, third, and ninth in the birth procession.

children to have higher intelligence quotients than their earlier-born siblings.

Twenty-six, or 20%, of the youngest children fell above intelligence quotient 100, and 16, or 12%, fell above 110 Twenty-one, or 16%, fell below intelligence quotient 70 In 43 cases one of the siblings of the youngest child was found to be feebleminded Every youngest sibling in this group of 43 families fell below 110 in intelligence quotient Three children, or 7%, fell above the intelligence quotient level of 100 The mean intelligence of the youngest siblings in these cases was 74, and 12, or 28%, were found to fall below intelligence quotient 70 (out of these 43 cases) In 17 families both of the examined siblings of the youngest child were found to be feebleminded. The mean intelligence quotient of the youngest child in these cases was found to be 65, and 8, or 47%, were below intelligence quotient 70 Every child in this group fell below 100 in intelligence quotient

The Pearson product-moment coefficient of correlation between the intelligence quotients of the oldest and middle child of the 132 families was found to be .57± 04, that between the middle and the youngest 53±.04, while that between the oldest and the youngest was 46± 05 Application of the multiple correlation procedure for predicting the intelligence quotient of the youngest sibling from the oldest and middle siblings together results in a correlation coefficient of 57 It therefore appears that very little has been gained in the prediction of the intelligence quotient of the youngest by inclusion of the oldest child in addition to the middle Somewhat more gain is suggested by the addition of the middle child to the oldest These relationships are summarized in Table 1

Table 2 contains similar material for 48 families from which four children were examined at the Institute The tendency for intelligence quotients to increase in the birth procession is again noticeable. The correlation between the intelligence quotients of siblings tends to be lower than in the previous material except for a high correlation between the intelligence quotients of the second- and third-born siblings. These differences may be accidental The multiple correlation coefficient for the prediction of intelligence quotient of the youngest child from the other three examined represents a slight gain over those obtained by comparison of the

TABLE 1

r_{12} = .57± 04	M_1 = 78±1	σ1 = 18 2
r_{13} = 46± 05	M_2 = 84±1	σ2 = 18 9
r_{23} = 53± 04	M_3 = 85±1	σ3 = 19 6

$r_{3.12}$ = .57

Prediction formula for intelligence of youngest

$$\bar{X} = 25\,X_1 + 42\,X_2 + 30\,5$$

TABLE 2

$r_{12} = 36 \pm .08$	$M_1 = 80 \pm 2$	$\sigma 1 = 15\ 0$
$r_{13} = .32 \pm\ 09$	$M_2 = 82 \pm 2$	$\sigma 2 = 19\ 2$
$r_{14} = 32 \pm\ 09$	$M_3 = 85 \pm 2$	$\sigma 3 = 15\ 7$
$r_{23} = 65 \pm\ 06$	$M_4 = 89 \pm 2$	$\sigma 4 = 20.5$
$r_{24} = .46 \pm\ 08$		
$r_{34} = 46 \pm\ 08$		

$$r_{4\ 123} = 53$$

Prediction formula for intelligence of youngest

$$\overline{X}_4 = 21 + X_1\ 26\ X_2 + \ 33\ X_3 + 22\ 2$$

youngest with the next youngest or next oldest It represents a more definite gain above the prediction of the intelligence of the youngest from the eldest alone

The multiple regression equations of Tables 1 and 2 weight the intelligence quotients of the siblings progressively more heavily as they are more nearly adjacent in the birth order to the child whose intelligence is predicted

The results of various studies (1, 2, 3) in the sibling correlation in intelligence *center around a coefficient of 5* The *significance* of this is made more clear by remembering that if we neglect the slight tendency for later-born siblings to have higher intelligence quotients than earlier-born siblings, assume the same variability in intelligence for the various birth positions, and accept 100 as the mean intelligence quotient of the community, then this means that our prediction of the intelligence quotient of a later-born sibling will be 5, as far removed[3] from 100 as the intelligence quotient of the earlier-born siblings. If the intelligence quotient of the earlier-born child be 120, our prediction for his sibling will be 110 If the earlier-born have an intelligence quotient of 50, *the prediction for his* sibling will be 75 For every case in which it falls above 80, we should expect another in *which it would fall below* 70 For every intelligence quotient above 100, we should expect another below 50

Clearly the net social value of the younger siblings of children of intelligence quotient 50 will be entered "in the red." Making logical exceptions

[3]The mathematical justification depends upon the relation of r to the regression line The regression equation for y is

$$\overline{y} = r \frac{\sigma_y}{\sigma_x} x$$

We have assumed $\sigma_x = \sigma_y$

Therefore $\overline{y} = r\,x$

Since we have assumed $\sigma_x = \sigma_y$ and $M_x = M_y = 100$, it follows that y is r times (in this case 5 times) as far removed from 100 as x

of those cases where the deficiency of the first child is acquired, e g, a result of epidemic meningitis, will leave a larger net deficit for the remainder.

A prediction slightly more accurate than that discussed is possible by taking account of the tendency for the intelligence quotient to rise down the birth order This may be done by adding 2 points to the prediction for every place in the birth order between the examined sibling and the sibling whose intelligence is predicted.

Conclusions

1 There is some indication that the correlation in the intelligence quotients of siblings is slightly higher when closely adjacent siblings are compared then it is when those more removed from each other in the birth procession are compared

2. There is but slight increase in the possible accuracy of predicting the intelligence of the next child by including more than one sibling in the prediction formula over that obtained by using the youngest available sibling.

References

1 Jones, H. E A first study of parent-child resemblance in intelligence *27th Yrbk Nat Soc Stud Educ.*, 1928, Pt. 1, 61-72

2. Thorndike, E. L The resemblance of siblings in intelligence *27th Yrbk Nat Soc. Stud. Educ*, 1928, Pt 1, 41-53

3. Willoughby, R R Family similarities in mental test abilities, *27th Yrbk Nat Soc. Stud Educ.*, 1928, Pt 1, 55-59.

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IS VISION THE CUE USED BY RATS LEARNING THE STONE MULTIPLE-LIGHT DISCRIMINATION PROBLEM?

Emir Allen Gaw and Calvin P Stone

The purpose of this experiment was to determine the validity of Stone's tacit assumption that the primary cue used by rats in learning the multiple-light discrimination problem (2) is visual rather than some other sensory cue, as yet unrecognized. Until contrary evidence is at hand, one may legitimately postulate that correct responses may be made on the basis of thermal stimuli provided by the illuminated glass windows, odoriferous substances diffusing from the lighted window and the sawdust trail of the correct (lighted) side, or by still other secondary cues provided by the experimenter in his manipulation of the apparatus

Male albino rats approximately 90 days of age were used in the experiment. They were divided into two groups One group, 14 in number, was

blinded under deep anaesthesia before the start of the experiment and hereafter is called the originally blind or OB group The other, 19 in number, was required to learn the discrimination problem before they were blinded and for that reason is known as the originally seeing or OS group.

Immediately before training for discrimination, all animals were given an opportunity to obtain food at the end of a straight, 10-foot alley twice daily on two successive days On the third day, training proper was begun with the lights shifted in successive trials according to the method of Stone (2). The OB group was given a total of 50 trials at the rate of two per day. The OS group, on the other hand, was trained until the animals could react correctly to the lights on three or more successive trials. Owing to individual differences in rate of learning and steadiness of performance, about half of them were blinded after 30 trials and the other half after 40 trials Thereafter all were given 50 additional trials with no change in the experimental procedure Food reward was the incentive for action and from the beginning to the end of the experiment all animals were strongly motivated.

Results

The error curve of the originally blind group is shown in Figure 1 and the data from which the progress of error elimination can be followed are given in Table 1 Scores for each segment of 10 trials were grouped and the mean, sigma of the mean, and standard deviation of the distribution calculated for each segment. Critical ratios for differences between means of the successive groups of 10 trials are also given in this table Upon examining the error curve and critical ratios, one notes a small and insignificant drop in the first 10 trials, but no appreciable change thereafter This early drop arises from the fact that rats quickly cease to repeat erroneous choices in individual chambers within the same trial

Previously it has been shown in experiments involving this same pro-

TABLE 1

Originally Blind Group

Means, sigmas of the means, standard deviations of the distributions, and critical ratios of differences between mean numbers of errors on successive groups of 10 trials each

				D/σ_D			
	M	SD	σ_m	2	3	4	5
1	26 29	2 79	75	1 10	1 45	38	2 03
2	25 21	2 37	63		.61	81	.71
3	24 50	3 68	98			1 26	05
4	25 93	2.15	57				1 64
5	24 43	3 42	91				

gram of light shifting that normal animals easily master the problem of correct choices within 30 to 40 trials One is justified, therefore, in concluding from the foregoing results that blind animals in a series of 50 trials are unable to discover alternative sensory cues with which to make correct choices Whether they would be able to make such a discovery in a much longer trial series, however, we are not called upon to say, for 50 trials is already beyond the limits of training given to normal, seeing animals in typical learning problems with this apparatus

Figure 1 gives the error curve for the originally seeing animals during their first 30 trials and for the same animals during 50 trials after the loss of vision. Their error data are summarized in Table 2, in which it may be clearly seen, upon inspecting the critical ratios, that significant differences obtain between successive segments of 10 trials while the animals were in possession of their eyes but never thereafter. From the immediate rise of the error curve after the animals were blinded, one

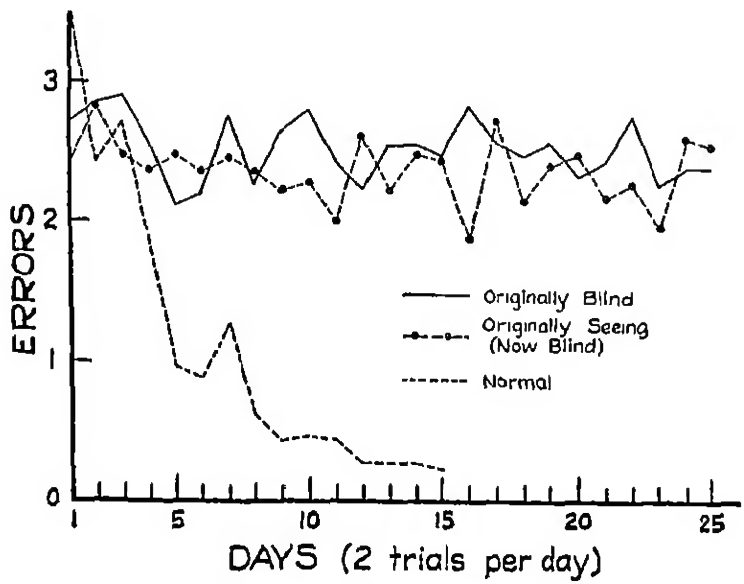

FIGURE 1

Error Curves as Based on the Average for Two Trials, the Daily Task

Logically, the curve of the OS group after being blinded should continue on from its curve while seeing To save space and to make easier the comparisons of the three curves it has been plotted as if it were a new series, which, in reality, it proved to be for the blinded animals

TABLE 2

ORIGINALLY SEEING GROUP

Normal for the first 30 trials and blind for the succeeding 50 trials Means, sigmas of the means, standard deviations of the distributions, and critical ratios of differences between mean numbers of errors on successive groups of 10 trials each The third series of 10 trials for the blinded animals is taken as representative of all of the others for purposes of comparison with the seeing animals

	M	SD	σ_m	D/σ_D 2S	3S	2B	3B	4B	5B
1S	22 73	5.33	1 22	10 13	14 69		49		
2S	7 32	3 95	91		4 15		15 89		
3S	2 84	2 54	.58				27 97		
1B	25 16	2 65	61			1.50	2 37	1 92	2.11
2B	23 53	3 95	91				16	30	39
3B	23.37	1 95	45					22	35
4B	23 16	3 69	85						.91
5B	23 05	3 46	79						

may infer that they were relying on visual cues for guidance when making the excellent performance at the close of their original 30-trial series. This inference is strongly supported by their failure to rise above chance performance during the next 50 trials.

As yet we have not learned why the OS group did somewhat better after blinding than the OB group, but it is suspected that the difference arises almost wholly from the fact that, after a bit of practice on this apparatus, animals cease to repeat errors in a given unit, that is to say, upon making an error they correct it immediately, whereas in the beginning they sometimes try two or three times to go through a closed door.

Observation of the behavior of the blind animals on successive trials gave some interesting information They soon formed position habits There were three chief types of these (1) right- or left-side position habits, (2) alternation habits, (3) combinations of both of the preceding types After familiarity with each rat had been attained, it was possible for the experimenter to predict with a high degree of accuracy what particular errors would be made on each trial.

A further inquiry into these records might prove of special interest in the light of the observations of Yoshioka (3,4) and Krechevsky (1)

REFERENCES

1 KRECHEVSKY, I "Hypothesis" versus "chance" in the presolution period in sensory discrimination-learning and the genesis of "hypotheses" in rats *Univ Calif Publ*, 1932, 6, 27-44, 45-64

2 STONE, C. P A multiple discrimination box and its use in studying the

learning ability of rats I. Reliability of scores J. Genet. Psychol., 1928, 35, 557-573.

3 YOSHIOKA, J G A note on the right or left going position habit with rats. *J. Comp Psychol.*, 1928, 8, 429-433.

4 ——— A further note on a position habit in rats *J Comp Psychol*, 1930, 10, 309-315

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ADOLESCENTS' MEMORIES OF PRESCHOOL EXPERIENCES

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What an individual remembers of his early childhood experiences depends upon a number of factors Ideas, and hence memories, are inseparable from language, for we think largely, if not entirely, in terms of gesture and vocalization Thus the extent to which a child has command of this instrument of communication—language—will determine his memories, and we cannot expect memories of the early language period, or the period when the child is just gaining control of language, to be numerous A second factor which goes hand in hand with language development is native ability or intelligence. The more intelligent the child is, or the greater his mental age in relation to his chronological age, the better able is he to learn and acquire language at an early age Obviously, if two children are chronologically four but the one has a mental age of five whereas the other one is of average mental age, then the one who is older mentally will in all probability have more memories dating to that period than the other child because of his superior ability

Although these two factors are primary, there are other factors which must be noted Probably every experience that we have is accompanied by some emotion either of slight degree or of great intensity, but most usually the experience which is remembered is the one which had a rather pronounced emotional tone. Thus emotion is a factor in memory Further we must note that the significance, meaning, or value which the experience has for the child at the time is a determining factor Obviously, what is significant for the adult is not necessarily so for the child Sometimes adults expect children to remember certain experiences which are never recalled by the child later, and are surprised that certain situations, which in their estimation were minor and insignificant, are recalled. We must note that the pattern of the child's experience is different from that of an adult and what may seem as merely an item or part to the adult is the whole pattern for the child.

In the present study we are primarily interested in the nature of the emotions, if any, which accompany the preschool experiences remembered

by adolescents The memories and relative information were obtained in the following way. A number of groups of college students were asked to write an account of the earliest childhood experiences which they could recall They were encouraged to recall the earliest experience they could remember and one that they were certain was an actual memory and not an account of their early exploits which has been frequently told by parents in their presence They were further requested to ascertain as accurately as possible, their age when the experience was had. It was suggested that they relate the experience to some incident the date of which could be discovered by consulting parents or other sources which would be reliable In many cases such incidents as the birth or death of brothers or sisters or other members of the family, moving from one place to another, remodeling the house, entering school, taking trips, and other such incidents were used as guides to the date of the particular experience remembered Some students knew the date of such incidents, and some others checked up with their parents so that their ages were exactly determined, and the other students were able to determine their ages within a few months Other information which was requested was a definite statement of the emotion or emotions, if any, which accompanied the particular experience recalled, and the student's date of birth

Of all the memories obtained, 200 were selected The others were discarded either because of insufficient information as to the particular emotion experienced or because the age was more than five. All the memories reported here date back to the students' fifth year or earlier The age range is from 1½ years, the earliest memory reported which merited acceptance, to 5 years. The number of reported memories of experiences had at various ages are: 1 at 1½ years, 4 at 2 years, 11 at 2½ years, 6 at 2¾ years, 39 at 3 years, 30 at 3½ years, 7 at 3¾ years, 60 at 4 years, 22 at 4½ years, 6 at 4¾ years, and 14 at 5 years The average age to which these memories date is 3 years 8½ months This age, however, cannot be taken too literally for there are obvious inaccuracies which could not be corrected.

As stated above, the primary aim of this study is to discover the emotions which accompanied the remembered experiences, and also to ascertain whether certain emotions are predominant.

As may be seen in Table 1, there are five emotions which were reported most often Of these, *fear* was the most common, including practically two-fifths (39 5%) of the cases; *joy* appears second in the list, including nearly one-fourth (24%) of the memories; *anger* ranks third, representing one-twelfth (8 5%) of the early experiences reported; *sorrow* and *disappointment*, and *wonder* and *awe* were reported by only 8 and 9 cases respectively (4 and 4 5%). Of the remaining memories, 17 included various emotions not mentioned above, and 22 did not involve any emotion

TABLE 1
CLASSIFICATION OF ADOLESCENTS' CHILDHOOD MEMORIES
(200 memories)

Emotion	Average age*	No. of memories	Per-centage
I *Fear*	3 9	79	39.5
1 Fear of punishment	4 0	15	7 5
2. Fear of animals	4 2	10	5 0
3 Fear as a result of falling	4 0	7	3.5
4. Fear of death	3 4	6	3
5 Fear of the strange	3 10	5	2 5
6 Fear due to accidents and runaways	3 4	4	2
7 Fear of storms	3 6	2	1
8 Fear following joy	2 11	2	1
9 Fear—miscellaneous	3 9	28	14
II *Joy*	3 7	48	24
1 Joy from gaining attention	3 11	10	5
2. Joy due to receiving food	3 4	7	3.5
3 Joy due to receiving gifts	3 4	6	3
4 Joy—birth of siblings	3 9	5	2 5
5. Joy—miscellaneous	3·6	20	10
III *Anger*	3 7	17	8.5
1 Anger as a result of punishment	3.7	8	4
2. Anger due to contact with other children	4 0	5	2 5
3. Anger—miscellaneous	3 1	4	2
IV *Wonder and awe*	4 3	9	4 5
V *Sorrow and disappointment*	3 10	8	4
VI *Various emotions*	3 6	17	8 5
VII *Incidents with no emotion indicated*	3 7	22	11

*Age is to be read as follows. 3·11 means 3 years and 11 months

Further examination of Table 1 reveals that the memories involving fear were further classified with respect to the nature of the situation which gave rise to the fear There are eight general situations which were reported, these are listed in their order of frequency Fear of punishment was the most common, including 15 cases (7 5% of the 200 memories) The following cases are representative of this group

The incident recalled by F D occurred the year before he entered school or when he was 3½ to 4 years of age. Since his older brothers and sisters were in school much of the time, F D had to play alone

> One day, while playing alone, I did something wrong (I don't recall what) and Mother went out by the clothes line to get a hazel switch Apparently I had had enough previous experience with hazel switches so that I knew what would happen At any rate, while she was gone I ran into the parlor shutting the double doors behind me, stayed in hiding for some

> time awaiting the whipping Strange as it may seem, I don't even recall whether or not I was finally whipped. (Anticipation of punishment)

V I, at the age of 4 10 was watching his father clean a cistern The father went into the house for a few minutes and it was during his brief absence that the following incident occurred

> I had been watching Dad clean the cistern and when he went into the house I tried to reach the top of the ladder so as to get down into the cistern which was about 10 feet deep I slipped and tumbled in, breaking my arm as a result of the fall While I was in there I thought of having to stay there all night for Dad had said before to me that bad and naughty boys would be put in the closet where it was dark and where the bogie man lived I cried for fear, and had a great deal of self-sorrow I even rationalized some, for I knew Dad would whip me for meddling I thought that I could say that I had dropped my handkerchief and wanted to get it, but I knew that that wouldn't do I had a vision, all the while I was in the cistern, of marching up the road to a certain willow bush and cutting a switch I was so afraid of this that I didn't even try to think of how I could get out Dad came out a few minutes later and got me out. I can well remember the whipping he gave me with a strap, which was the first whipping I got without getting my own switch

Fear of animals was the second most common type of fear situation reported Of the 79 memories involving fear, 10 belonged to this group Two of the incidents were experiences involving bulls, two involved horses, and the others involved a cow, a rabbit, a rooster, a gander, a bull dog, and a cat In practically every case, the child's experience was one of being chased, kicked, mauled, or bitten by some animal The following experience is typical of this group

F. L., who was exactly four years old at the time, was playing on a vacant lot where there was a rooster in a small enclosure

> I had been teasing the rooster for quite a while by poking him with a small stick and by throwing things at him Finally, after about half an hour, the rooster became so angry that he flew over the low fence which separated us and started for me Simultaneously I started for home which was a block away I ran as fast as I could and yelled at the top of my voice, for the rooster was right behind me Finally I succeeded in reaching home, and my mother thought the incident was an exceedingly funny joke

Five of the seven memories which involve fear as a result of falling were due to falling into a body of water such as a creek, river, or lake In only two of the cases was there any great danger that the children would have been drowned if they had not been rescued The seriousness of a situation as viewed by an adult is no index to the fear which may

be experienced by a child As much fear seems to be experienced by the child who falls into a puddle or shallow creek as by the one who falls into a river or lake.

A case of this type is that of K.U Although K.U didn't actually fall into the river, he came very near doing so and was thoroughly frightened as a result. K.U was three years old at the time the following incident occurred

> My nurse was taking me across the bridge, which spanned the Merrimac River, so that I might go shopping with my mother Since I insisted on lagging behind, my nurse finally became disgusted with me, let go of my hand, and stated that she was going on and that I could come whenever I got ready This happened in about the middle of the bridge Instead of going along with my nurse, I leaned over the railing to look at the river and became very dizzy I felt as if I were falling into that terrible chasm, and I remember that I wondered whether or not I could pass between two iron beams which were about a foot apart. Then I thought that I was resting on them, face down, halfway between the walk above and the river far below, with a train rushing overhead This latter part is recalled as being true, but it is not My mother states that I had almost fallen off the bridge when I apparently became dizzy, but that I was snatched up by a stranger before anything happened. A train was passing over the bridge at the time of the incident.

Six of the 200 memories reported involved fear of death Fear of death as a result of falling into water (these cases are not included in the preceding group), as a result of eating buttons and pills, and as a result of accidents. The following two memories are excellent examples of the type of situation which gives rise to a fear of death on the part of children

A few days before his third birthday, V.I, who at that time lived about a block from the river, wandered down to the river where the ice company was harvesting ice Accidentally V.I, who was then standing near the water's edge, was pushed or bumped into the channel A man standing nearby quickly fished the frightened boy out with a pike pole and carried him home "The emotion I experienced was fear of death And after I was again permitted to go outside, I didn't go down to the river because of fear, for I thought that I had just about lost my life"

A second case is that of L.S who was 3½ years old

> I had climbed up to the top of a barbed wire fence and by accident I fell off and hit my face upon a sharpened post which was lying on the ground I do not remember why I was on the fence, especially when I was there alone, or what happened that I fell All I can remember is that I was on the fence and fell off onto the post cutting my lip clear through for about an inch. I can remember no great pain, but the sight of blood flowing so freely almost frightened me to death, and

> I thought that surely I was going to die My screams attracted the attention of my mother and my aunt and brought them to my rescue I can distinctly remember how my aunt held me while my mother bandaged my lip with gauze and adhesive tape, and how she repeatedly told me that I was going to be all right and that I wasn't going to die.

The fifth group, including five memories, is fear of the strange of which the memory of F D, a boy, is typical

> At this time I had rather long curls hanging about down to my shoulders. My folks decided that for the sake of convenience the curls should be cut before my fourth birthday, but, desiring to preserve the image, they had a photographer come to take my picture. I recall distinctly a little white suit which I liked very much, but which I refused to wear on this particular day when I was told that I would have my picture taken In due time the suit was put on me forcibly and I was taken to the front porch, crying bitterly. The photographer was nice to me, however, and succeeded in getting me to cease crying, but not to smile The emotion was undoubtedly fear, fear of the strange and unusual.

Since most of the students who participated in this investigation were born in the horse-and-buggy days, or at any rate before cars were very common, they had some experiences which centered around such incidents as runaways. Four students reported early memories of runaways in which they were involved or which they observed Two students reported memories of severe storms of which the memory of G D. is typical

> One night when my father went to band practice, Mother, Dick, and I remained at home alone We went to bed about eight-thirty or nine o'clock and somewhat later it began to storm Mother is very afraid of storms, and, since we were home alone, she was so frightened that she awakened and dressed us and told us that we were going over to Grandmother's Since Dick was only a month old and I wasn't quite four, she could not carry the both of us and an umbrella also As a result she left me at home alone until my grandfather would come for me The lights were out and I sat in front of the lamp as still as I could until my grandfather came and got me It was thundering and lightning terribly. He didn't come for quite a while because my mother had slipped and fallen while on her way and it had taken her longer to get there My emotion was one of extreme fear

Two students reported memories in which joy was followed by fear, that is, they enjoyed a situation which later gave rise to intense fear The remaining 28 memories in which the emotion of fear predominated were due to a great variety of situations, such as, accidents of various kinds, sickness, doctors, being lost, losing toys, operations, et cetera

Thus we see that fear plays a large part in childhood memories and

that some situations are especially prominent. Since children are frequently punished for their misbehavior, and since the punishment is painful, they learn to fear chastisement and even to anticipate with much fear the punishment which certain behavior apparently merits One might have expected that fear of animals would have been reported more frequently than it was, since children have many such experiences Probably many of the experiences which children have, although not remembered, have a rather lasting effect on their behavior So also in the case of fear of storms Although many children have experiences with storms, apparently but few children remember specific instances Also it may be that children are conditioned to fear storms at a later age than that of the memories reported here

The emotion which ranked second in the line of frequency was joy, which was reported in 48 of the 200 memories, or in nearly one-fourth of the cases There are only four general situations which seemed to give rise to joy and which are common in a number of the memories These are, joy as a result of gaining attention (10 memories), joy due to receiving food (7 memories), joy due to receiving gifts (6 memories), which group is closely related to the preceding one It is also interesting to note that the average ages of these last two groups are the same The last type situation is joy attending the birth of younger brothers and sisters The remaining 20 memories in which joy was the emotion experienced were due to a great variety of situations A few typical memories in which joy was experienced follow

Q K, apparently an active little boy, had the following thrilling experience at the age of three and a half

> I can distinctly remember not wanting to be given a bath on a particular day and running out of the bathroom without a thing on The most distinct part of the incident was when I continued on through the house and out the door with the whole household after me Here I experienced great joy in the novelty of running around the block with a host of people running after me and screaming I am certain that the emotion was decided satisfaction in having such a novel experience and causing such an uproar.

L E. was a little girl four years of age.

> It was a bright summer morning. I was sitting on my bed putting my shoe on I had on a blue dress The door opened and in came my grandmother, my two aunts, and my twin sisters who had just returned from St Louis. O—, one of the twins, ran toward me waving a red purse in the air and saying, "See what we brought you" I remember that I didn't care that I was seeing my sisters for the first time in six months, but that the red pocketbook held the center of the stage The emotion was one of pride and joy in possessing the purse

When L X was a little girl, she lived on a ranch One day, when she was three years old, she went to town with her father and ate her first pear.

> I shall never forget my first experience with a pear. When I was three years old, my father took me with him in the grain wagon to town. When we arrived in town, Dad bought some pears I liked them; I had never seen a pear before, and it was delightful From that time, everytime I eat a pear my first experience returns.

G D remembers announcing the birth of her brother

> My brother was born when I was 3½ years old. I can remember asking if I could sleep with my mother the night before my brother was born, and that our maid said that I could not and that I had to sleep in my own room The next morning when the maid awoke me she said that she had a surprise for me She brought me downstairs with her and there in a basket I found my baby brother I was awfully excited and couldn't eat any breakfast until I ran around and told all the neighbors Since it was May, I didn't want to wear a coat. The maid, however, insisted that, since it was early in the morning and chilly, I wear my black-and-white checked coat, but I could hardly wait until I buttoned it and ran out to announce that I had a baby brother

I L distinctly remembers that on his third birthday he went over to visit the neighbors and that when he was asked concerning his age, he proudly replied that he was three years old

When A C was a little girl of four, she had the following experience.

> I remember this incident very clearly for it was about five days before my fourth birthday. It was the fall of the year and we were having thrashers at our house Mother was so terribly busy that she did not have time to watch me, and told me that, since we were going to have a lot of men to dinner, I would have to stay out of her way I couldn't think of anything to do, but finally I found some pails with red and white paint in back of the garage. (We had painted the house and garage lately.) I started to play with the paint and then I thought that I would make my hair white and my hands red After I did this awhile, I began to feel sticky and uncomfortable and so I ran into the house I remember that the tables were set and that dinner was nearly ready. When Mother saw me come in all painted up, she threw up her hands in horror What was she to do? There was no one to help her and the men were ready to come to dinner She also knew that if the paint dried that she could never get it off All this time, I was having a good time. I can remember looking into the mirror and laughing at myself But when my mother dipped my head in kerosene, I did not laugh any more, for I hated the smell of kerosene, and it hurt when she tried to rub the paint out

Joy at seeing her first movie Z C, five years of age

> I remember very clearly that when I was five years old I was permitted to see my first movie, "Jack and the Bean Stalk," at a special matinee for children. My two older sisters were going and I can remember asking my mother if I might go too, and of standing in intense anticipation awaiting her answer I can see her plainly She was kneeling before a dresser, opening the bottom drawer, and I was standing in the door Finally she assented and my emotion changed from one of anticipation to one of unbelievably hilarious joy Concerning this same incident, while in the theater, I remember sitting behind a little boy with whom I often walked to school and whom I liked very much My emotion in this case was one of excitement and self-consciousness. Later, during the movie, I remember how the giant carried off the little girl and how she kicked her legs furiously. I was so frightened that I cried and both my sisters were terribly embarrassed and rather impatient.

The emotion which ranks third is anger Since this emotion was named in only 17 of the 200 memories studied, situations which incite anger are apparently not usually remembered Certainly we cannot say that children do not become angry, but rather that such situations do not make a great impression upon children, or that they forget such situations because they are taught to thwart anger. Anger or resentment resulting from punishment, especially from punishment which seems unjust in the eyes of the child, is the most common situation reported, including 8 of the 17 memories Anger due to conflict and quarrels with other children was reported in 5 memories The remaining situations which resulted in anger were such as being forced to take castor oil, being deprived of a favorite dog, being forced to wear shoes which were disliked, and plans being frustrated by parents Some of the more typical memories in which anger was experienced are given below

V L, a little girl three years of age, was terribly angry at her mother who punished her

> One afternoon when I was restless and didn't know what to do, Mother suggested that I play with my dolls and watch her cut out a dress The material she was cutting was the kind that frays very easily and so she was cutting off the fringe This gave me an idea I ran into another room where I found a pair of scissors; then I climbed up on the piano bench and snipped the fringe off the piano scarf. (Those were the days when they had long fringed piano scarfs) When I had finished cutting, I called Mother and asked her if it wasn't pretty This was followed by my first spanking which angered me I didn't like Mother for days, I wished her all sorts of bad luck. I thought that she was very mean, and I liked everyone else better than Mother And that evening I stayed upstairs and cried and refused to eat my supper

B K's memory is of a quarrel she had when she was four years old.

> I am the youngest of four girls in our family The sister next to me and I always quarreled, even when we were very young we quarreled more than either of us did with either of our other two sisters I have always had a violent temper, and at times it has been hard for me to control it This particular incident happened when I was about four years old Even as a youngster I was the type who took things from people for a while without getting angry and then suddenly I would just blow up. That afternoon K——— and I were up in the playroom and she, as usual, had been "picking on me" She had one trick or habit which she knew I detested and so she persisted in doing it That habit was pinching my cheeks I stood for a lot of pinching and having my dolls taken away from me for quite some time Finally, however, we got to open quarrelling and I lost my temper very suddenly and blindly I grabbed a button hook and made one dive for her face with it. The result was that the button hook caught in the lower lid of her right eye and hung there I can still see it. It looked so funny that I began to laugh while she sat there crying just as hard as she could Of course, I had absolutely no realization that I might have seriously injured her Her weeping brought Mother who properly scolded me The doctor was called and after he had removed the button hook from her eye, I can remember that he and Mother sat down and explained to me how very seriously I might have hurt my sister

A third memory involving anger is that of Q N (female) who had the following experience at the age of 2 8

> I had always been spoiled, that is, Grandmother usually gave in to me when I insisted (which was often), but this one time everybody was dreadfully obstinate I have always, even as a child, liked pretty, dainty clothes—shoes especially On this occasion, Grandmother bought for me a pair of black, square-toed, broad, ugly, high-laced shoes I didn't like the looks of them, I hated the feel of them, and rebelled against wearing them I can remember scuffing the toes and kicking things about when I had to wear them, and finally I deliberately took a pair of scissors and scratched the already marred leather beyond repair. The more the family insisted that I wear the shoes, the more I resolved not to, for I greatly resented the attitude on the part of my parents

Wonder about the mysterious was experienced in connection with nine of the memories Three of these had to do with deaths or funerals The others resulted from sundry situations, such as visiting a zoo in a park, seeing a pig drink beer from a bottle, and others A particularly interesting case is that of Z C who at the age of five wondered a great deal about the following incident

> When I was four and a half or five years old an incident occurred which made a lasting impression on me. One stormy summer evening I was sitting with the family in the living-

> room It was raining hard, and was a most unpleasant night Suddenly someone knocked at the side door, one which we seldom used, and my father went to open it At the door was a young girl, who lived around the corner, holding her very young baby My mother had promised her one of our old cribs and some baby clothes, and she had come for them After she had gone, my father asked my mother if it wasn't rather foolish to bring such a young child out into the cold rain My emotion was one of perplexed bewilderment and also wonder. The mysterious element which entered, although I didn't realize it at the time what it was, was fascinating and puzzling. I remember, also, that there was something mysterious and not quite nice about the whole affair My father and mother said things which I did not understand, and yet, young as I was, I distinctly remember feeling that something was wrong

Sorrow and disappointment appeared nearly as frequently as anger—eight memories The sorrow and disappointment, for the most part, was due to being deprived of favorite possessions or due to a frustration of the child's plans In only one case was a little girl sorry for her sisters who got into difficulty with a neighbor lady. An interesting case of disappointment is that of Q N, a little girl exactly four years of age

> At the time I was four years old, my baby brother was the chief attraction and I was being very much neglected I can remember determining to run away and not return I did not go far, I merely walked across the street to a friend of my mother and played in her garden, alone, all day. I can recall how I expected them to search for me, and worry about me. Finally,I grew tired of my plan and returned many hours later, to find, to my chagrin, that I hadn't even been missed I can also remember hearing the maid reprimand me for coming and walking all over her cleanly scrubbed floor The incident would never, I believe, have been retained if I had not been so dreadfully disappointed when I found that I hadn't even been missed

The last group of memories which involved emotion includes experiences which elicited a variety of emotions no one of which was represented by a large number of cases One memory involved surprise, another jealousy, a third disgust and repulsion, while another elicited shame, and still another affection. Two memories included a feeling of strangeness, and three embarrassment, whereas resentment was reported in two, dislike and hate were mentioned only once each Curiosity was manifest in only three of the memories Some of the more interesting memories of this group are given below

Jealousy was experienced by S C, a small boy four years old

> I remember that at the ripe age of four years the "gang," consisting of four boys and one girl, decided to play house There was an argument as to who was to play the part of

> *the father which the oldest boy, perhaps three years older than* the rest of us, decided by choosing the honor for himself and maintaining himself in that position The rest of us were very jealous of him, and after that we had a feeling of contempt for him instead of a friendly feeling as previously.

At the early age of 2 8, Q D. experienced disgust and repulsion

> One summer our family went on the train out West to visit some friends who lived on a ranch The town at which we arrived, which was nearest the ranch, was a typical western village and the only place we could get anything to eat was in an old Mexican restaurant. The place was none too clean, and, since it was a warm day, flies were very numerous I must have experienced a vivid emotion of repulsion at the filthiness of the place, because whenever I think of that trip I always recall the unsanitary condition of that old Mexican restaurant

In the last case, Z I, when a little girl at the age of four, experienced shame

> When I was a little less than four years old, my sister and I shared the ownership of a little writing desk. Sister, being *older than I, was inclined to monopolize the desk at times* One day I wanted to play at it but she refused, so I took my crayons out of one of the nooks of the desk and asked for some paper to draw on She refused me the use of her paper also Upon being refused the second time, I ran into Mother's bedroom and scribbled on a patch of wall paper almost as big as I was This act was wholly impulsive, and was the only way I could *give vent to my feelings When Mother discovered it, she* spanked me and scolded my sister for not giving me paper Afterwards I was very much ashamed of my act A few days later Mother was sick and the doctor was called to visit her During his visit, I stood up as tall as possible to cover the crayon marks I had made on the wall, and of which I was ashamed

In the last group, labelled "Incidents with No Emotions Indicated," 22 memories are included which are merely recollections of incidents Either no particular emotion was experienced at the time of the incident, or else *the emotion was not of sufficient strength* so as to be remembered At any rate, no particular emotions were indicated by the students reporting these memories

Some of the memories are such as that of one student who recalls that, when he was two years and ten months old, his brother was born Also that at three years he was crossing a railroad bridge and that he had to take long steps in order to step from tie to tie Another student remembered that at the age of four he was being taught how to write his name by his father A most interesting case is that of a student who reported four memories, each of which is the memory of an odor At the age of 3 6,

he had a ride in a push cart made from an old lawn mower which smelled of "*musty oil and earthy grass*" *At four, his aunt asked him to kiss his* boy cousin who had a "peculiarly clean odor," and another day about this same time his mosquito bites were rubbed with a preparation that had a "queer smell" At the age of five, he and a little girl played in a tent which in the hot sun gave off a "peculiar odor" This individual has an excellent sense of smell and states that many of his memories are in terms of this sense

Thus, from a perusal of the results obtained in this study, we find that for the most part the memories which adolescents have of their preschool experiences are of situations and incidents which gave rise to some emotion We also found that the emotion which was remembered most often was fear, which included 39 5% of the 200 memories studied, and that, of this group, fear of punishment and fear of animals head the list

Although joy appears second in the list, it includes only 24% of the memories The particular situations which seem to elicit joy most often are such as when the child is the center of attraction, or when he is receiving things from others, as gifts or food Upon closer observation, we find that both of these situations are very similar, for when a child is receiving gifts he is also receiving attention

The third group we found was anger which included 8.5%, or 17, of the 200 memories Quite apparently anger is not remembered nearly as frequently as fear and joy In the case of every memory involving anger, the anger was directed at other individuals rather than at objects or conditions All of the other emotions mentioned, such as sorrow and disappointment, wonder, curiosity, embarrassment, strangeness, resentment, and the others, were decidedly in the minority This is significant in view of John B Watson's findings concerning emotions He posits three emotions, fear, rage, and love, which in his estimation are the only emotions to be found in the behavior of infants Our results also seem to corroborate the belief of most contemporary psychologists that the emotional repertoire of most children is very limited, but that, as they become older, increase the range of their experiences, and gain control over their responses, their emotions become refined and differentiated into emotional shades which later are labelled with specific names Since this process of conditioning has not progressed far in children at the ages we are considering, we cannot expect a large number of memories involving these other emotions, which in all probability are just beginning to develop

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MENTAL RETARDATION AS A RESULT OF BIRTH INJURY[1]

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Among the many dangers which attend childbirth is the likelihood that the newborn infant may sustain serious damage to the central nervous system Such damage is known to account for a large amount of infant mortality and morbidity. This hazard is known to be present in apparently *normal births with spontaneous deliveries, as well as in instrumentally* assisted births

The most common mechanism of cerebral birth lesion is intracranial hemorrhage due to trauma Imperfect myelination, infectious processes, and other causes are also to be considered These conditions produce motor impairment, mental retardation, or disturbances of personality

The two principal types of motor handicap resulting from birth injuries *are spastic paralysis and athetosis* Spastic paralysis represents essentially simultaneous contraction of antagonistic or reciprocal muscle groups, accompanied by a marked degree of *hypertonicity Athetosis represents fairly* well coordinated voluntary movement which is interfered with and confused by successive superimposed involuntary contractions of muscle groups throughout the extremities Most cases present a combination of spasticity with athetosis Other forms of motor impairment may also be present in greater or less degree (3).

in various degrees and in different combinations in individual patients Thus, the clinical symptoms may be principally motor, principally mental, principally temperamental, or any combination of these.

Heretofore, interest in these cases has centered chiefly on the neurological and obstetrical features and the associated problems of body mechanics Psychological interest has awakened only recently Yet this condition raises questions of profound practical and theoretical import in the fields of clinical and genetic psychology regarding the neurological antecedents of behavior and development These subjects present congenital non-progressive disturbances which gravely interfere with the development of expressive behavior of cerebral origin

There is reason to believe that in many cases the milder degrees of injury are outgrown or compensated for and that in nearly all cases mental and motor development proceed at a greatly retarded rate The most common method of treatment is muscle training, although some operative procedures have been successful.

The present report is based on four years of study of a group of 44 subjects at The Training School at Vineland, New Jersey The point of departure in these cases is the presumption of mental deficiency The majority of the cases revealed mental retardation associated with motor difficulties. Our experience thus far with mentally normal cases has been limited to only a few individuals of average and superior-average intelligence We have encountered few cases where the principal consideration was personality disturbance. It is suspected that we have overlooked many possible cases of mental retardation without motor symptoms more or less directly traceable to the same cause

The survey figures themselves are of some importance Eleven cases, or 2 5% of our total population group, have been diagnosed as definitely birth-injured; 17 cases, or nearly 4%, have been diagnosed as probably birth-injured, and 16 cases, or 3 6%, as possibly birth-injured This shows from 6 to 10% of a fairly representative institutional group of mental deficients in which the presumptive etiology is birth injury This is numerically the largest single etiological category of mental deficiency outside the field of heredity. This result is in harmony with similar studies elsewhere (2).

The medical diagnoses have been made by Dr. Winthrop M Phelps, Professor of Orthopedics at the Yale University School of Medicine, based on a combination of neuromuscular symptoms and birth histories Pathology other than birth injury is negative in 70% of these cases, heredity is negative in 80% of the cases; both heredity and other pathology are negative in 55% of the cases However, even where other pathology or heredity is present, there is nevertheless a strong presumption that the actual cause of the condition was the birth injury

Special attention has been given in our study to developing improved methods of mental examination in these cases Speech and motor handicaps limit the number of standard mental tests which can be used and make necessary certain modifications of procedures in practically all examination methods This aspect of our study has been presented elsewhere (1)

In our later studies we have employed the motion-picture technique in order to study the nature and amount of improvement obtainable with such subjects under physical therapy, especially muscle training The pictures follow a research routine which has been developed during the past two years The routine reveals the action of the principal muscle groups in both formal and practical situations.

From the scientific point of view, special interest attaches to this condition because of the recent work of Coghill on the anatomical foundations of behavior development, the work of Lashley on the relation of cerebral damage to adaptive behavior, and the work of Shirley on the genetic sequences of motor development in the normal infant Our further work will be devoted to observing the order and rate of motor development in these patients and their adaptive compensations

REFERENCES

1 DOLL, E A , PHELPS, W. M , & MELCHER, R T Mental deficiency due to birth injuries. New York Macmillan, 1932 Pp. 289

2 LARSEN, E J. A neurologic-etiologic study on 1000 mental defectives *Acta psychiat et neur*, 1931, 6, 37-54

3 PHELPS, W. M Cerebral birth injuries their orthopaedic classification and subsequent treatment *J Bone Joint Surg*, 1932, Oct, 773

4. SCHROEDER, P L Behavior difficulties in children associated with the results of birth trauma *J Amer Med Asso.*, 1929, 92, 100-104

5 SMITH, G B Cerebral accidents of childhood and their relationships to mental deficiency *Proc & Add. Amer Asso Stud Feeble-Minded*, 1926, 21, 77-98

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MENTAL WORK CERTAIN OF ITS CHARACTERISTICS[1]

EDWARD A ABDUN-NUR

The objective of this study is to determine a better way of arriving at a group curve, and to correlate the different objectively measurable influences making up determining factors in mental work and its decrement.

[1]This investigation was made under the direction of Dr Thomas R Garth, Professor of Psychology at the University of Denver, as a Master's thesis

THE EXPERIMENT

The experiment consisted in measuring the amount of work done by each of 118 seventh- and eight-grade white children, on addition problems, in each successive 2-minute period The average age of the group was 163 33 months, and included 67 boys and 51 girls.

A set made up of 24 Thorndike Addition Sheets was used There are 7 different sheets in the series, which were used over and over again to make up the set From a careful examination of the answers on similar sheets, it was found that the children did not recognize the similarity, probably due to the pressure of time caused by strong motivation, and competition Each sheet had three rows of 16 problems, each of which consisted of a column of 10 single digits to be added No 1's and 0's were used in making up the problems on these sheets, and they are, according to Garth (2), "so arranged, that any successive five of these columns are of a difficulty, nearly, if not exactly equal"

The pupils were told that the experimenter wanted to find the best adder.[2] He passed the pads face downward and told them to turn them over and add on the first page when he gave them a signal After 2 minutes, he told them to turn over to the following page, then after 2 more minutes he asked them to start on the third page, and so on, until 21 2-minute periods had passed, when they were told to rest for 5 minutes This rest period was free and unrestrained. After that, the three remaining sheets were used up after the same manner The pupils were not told of the approaching end, but they very likely realized during the 5-minute rest period that there were only three more sheets left

In addition to the fatigue test, the children were given the National Intelligence Test [a discussion of which as a measure of intelligence is given by Whipple (6)], and the first three parts of the Compass Diagnostic Test in the Addition of Whole Numbers, Form A The latter was taken as the measure of their addition ability

GROUP CURVES

The original data were tabulated to give the number of problems solved correctly, and the number attempted during each period, and the total for the 24 periods This gives us two series, the attempts series and the accurates series

It has been suggested that the two series thus obtained do not give a true picture because they allow more weight to the better workers, and that a remedy is supplied by working out two other series made up of the percentages obtained by dividing the attempts for each period by the total attempts for each individual, and in the same manner dividing the accu-

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[2]The tests were administered by Mr. N C Kephart, a senior student in psychology at the University of Denver.

rates per period by the total accurates. Recognizing the theoretical accuracy of this contention, we made up two similar series, the percentage attempts series and the percentage accurates series

With these four series, it would take a pair of curves in each case to give a complete picture of what is happening, as speed and quality are thus kept separate If we are to judge from one curve alone, we would be assuming that the other is unimportant Our problem was then to combine both factors in some way to give us a composite curve that would involve both Reed (5) has done this by using a right-minus-wrong series, which seemed to us to possess certain desirable features, and we worked one for our data This, however, did not meet the objection mentioned above, so a percentage series was derived to take account of both speed and accuracy by dividing the number of accurates in each period by the total attempts for each individual This, in a sense, gave the efficiency of the performance of each period in terms of the maximum possible for that individual in the test. This series makes it possible to compare it with the percentage attempts series because it has the same base, whereas it would not have been possible to compare the latter with the percentage accurates series, because they did not have the same base We shall refer to this series as the combined percentage series. Thus we had six series

Series I—Attempts series
" II—Accurates series
" III—Right-minus-wrong series
" IV—Percentage attempts series
" V—Percentage accurates series
" VI—Combined percentage series

The next problem was to combine each series of the 118 cases into one group curve showing the central tendency To determine that, we made frequency distributions of each period for each one of the six series No definite relation was found from these distributions as changing over from series to series seemed to change the skewness in a very haphazard way There was one point brought out, however, by these distributions, and that is that they approximated a normal distribution rather closely By inspection, the problem was narrowed down to a choice between the arithmetic mean and the median Both of these were calculated for each period, for each series, and were plotted in one pair of curves for each series From a study of these six pairs of curves, we found that they practically coincided all the way through, and that they had very few points that differed from each other by more than one probable error From that we concluded that the use of either average would be justified, and, because the mean is more stable, we decided to use it

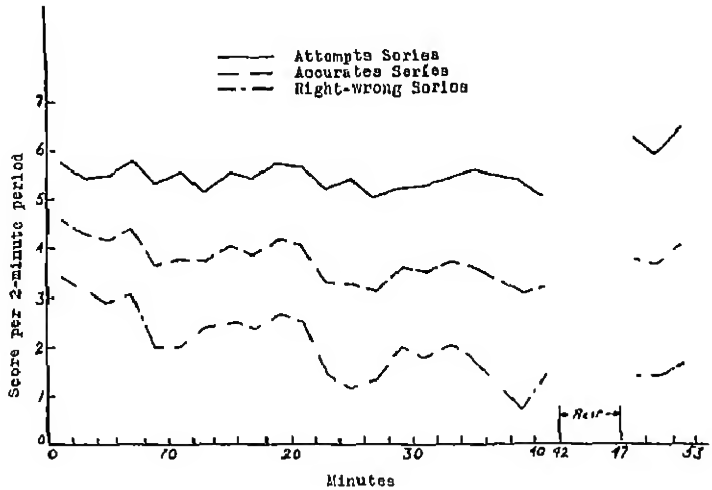

FIGURE 1

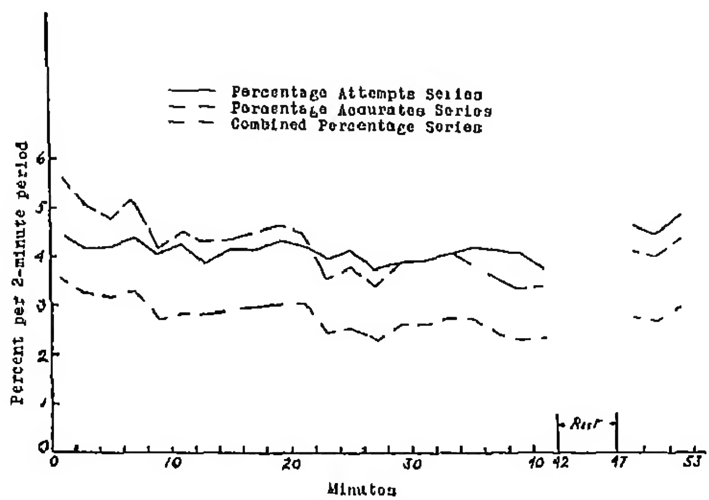

FIGURE 2

TABLE 1

	Between 1st and 2nd	Between 23rd and 24th
Attempts series	93 chances in 100	94 chances in 100
Accurates series	89 " " "	89 " " "
Right-minus-wrong	80 " " "	80 " " "
Percentage attempts	97 " " "	98 " " "
Percentage accurates	95 " " "	92 " " "
Combined percentage	90 " " "	88 " " "

Using the arithmetic mean, the group work curves for the six series are given in Figures 1 and 2

WORK-CURVE ANALYSIS

We see from an examination of all six curves that there is a decided drop between the performance of the first and second periods, also between the 23rd and 24th periods The probabilities that these differences are real are given in Table 1 From this table it is seen that these differences are fairly certain to be real, and thus show at least the probabilities of the existence of initial and end spurts.

The next question is how to calculate the total work decrement or fatigue *from these curves In measuring the performance at any point of the curves, we have taken the average of three successive periods as giving a truer picture than that of one period, due to the limitations of the sample.* Such averages were figured for all six curves at the following points. (1) periods 1, 2, and 3 or beginning of the work curve, which we designate as point "*a*," (2) periods 19, 20, and 21, or the periods immediately preceding the rest, designated as "*b*," and (3) periods 22, 23, and 24, or the periods immediately following the rest, designated as "*c*" To make our fatigue and our recovery after rest comparable, we have used a common base in point "*b*," and thus we have in terms of percentage

$$\text{"Fatigue"} = (a-b)100/b, \quad \text{and}$$
$$\text{"Recovery"} = (b-c)100/b.$$

The second equation gives a negative value, but if we keep in mind that

TABLE 2

	Fatigue	Recovery
Attempts series	4 75%	17 34%
Accurates series	36 43%	20 34%
Right-minus-wrong series	188.93%	33.77%
Percentage attempts series	7 32%	17 90%
Percentage accurates series	49 67%	22 03%
Combined percentage series	40.17%	21 04%

recovery is negative fatigue, we do not need to carry the sign in the rest of this discussion Table 2 gives these results.

It is seen that, except for the two series involving attempts, the fatigue is always greater than the recovery. But even in these two series the recovery figures run about the same as the other series, whereas the fatigue figures vary considerably The close similarity of the recovery figures is further emphasized if we throw the right-minus-wrong series out of consideration. The reason that this is suggested is that it is seen from that curve that it is extremely variable, and we found from a calculation of the coefficients of variation that it is not reliable, particularly when compared with similar coefficients for the other five series We also find that the differences between points "*a*," "*b*," and "*c*" are statistically significant in all cases but two, which are between "*a*" and "*b*" in the attempts series and between "*b*" and "*c*" in the right-minus-wrong series. The chances in these two cases are 96 and 93 in 100, respectively, that these differences are real. We also see by inspection that the series that have accurates in their make-up show greater fatigue than those that are based on attempts only

Reed (5) advances the view that the difference between the work immediately preceding rest and that immediately following it is a better measure of fatigue than the difference between the work at the beginning and that preceding rest. In other words, what we have so far called "recovery" is a better measure of fatigue than what we have termed "fatigue" The reason is that at point "*a*" the task presents some strangeness which will have worn off by the time the rest pause has been reached, and at point "*a*" practice has not had a chance to reach a maximum because the pupils have not very likely used similar problems for quite a while, but by the time they have worked on them for 21 2-minute periods they would have reached that maximum in such a simple process as this. It is just like taking the end of the curve and attaching it to the beginning in order to avoid some of the disadvantages inherent in the beginning of the task It would have been still better if we had had more than three periods after the rest in order to avoid having the end spurt affect our calculations.

This reasoning presupposes the fact that the rest pause was long enough to overcome the effect of fatigue Bills (1) says that recovery from fatigue takes place within 5 minutes of rest Graf (3) finds that the optimum length of a rest pause is 2 minutes for one hour's work, placed after the second third of the working period Hollingworth and Poffenberger (4, pp. 179-196) find that, in general, 5 minutes of rest for each hour of work gives best results From this it would seem that our rest pause very nearly approximates these best average conditions and therefore we may use Reed's argument given above

TABLE 3

1—Fatigue	2—Intelligence	3—Arithmetic	4—Age
Mean=56.73	Mean=129 65	Mean=189 35	Mean=163 00
S D= 12 95	S D= 17 69	S D.= 7 66	S D= 10 91
$r_{12}=+ 04\pm 07$	$r_{23}=+ 17\pm 06$	$r_{34}=- 07\pm 07$	
$r_{13}=+.08\pm 07$	$r_{24}=+.06\pm 07$		
$r_{14}=- 11\pm 07$			
	$R_{1(234)}=+ 14$		
	$\text{P E.}_{(\text{est } X_1)}=8\ 66$		

Correlation

In working on the correlations we tried to find the influence on (1) fatigue of (2) intelligence as measured by the National Intelligence Test, (3) the arithmetic ability involved in our fatigue test as measured by the first three parts of the Compass Diagnostic Test in the Addition of Whole Numbers, and (4) age See Table 3 For a measure of fatigue we used the combined percentage series, because we felt that it is more reliable than the right-minus-wrong series as was explained above, and these two were the only ones out of the six series to combine the effects of both speed and accuracy We used also, as explained above, the difference between the work done immediately before the rest and immediately after the rest as a measure of work decrement. The regression equation obtained was

$$X_1 = 03X_2 + 11X_3 - 12X_4 + 53\ 45$$

The coefficients of X_2, X_3, and X_4 are in the ratios of 1·3 75 4 44 respectively. This indicates that age is the most important factor, followed by arithmetic ability, and finally by intelligence, the last named has a rather small effect, compared with the other two These figures, however, indicate very general and unreliable trends rather than definite reliable findings because of the smallness and insignificance of the coefficients of correlation

Conclusions

What then can be concluded from this study?

1 That in obtaining a representative group work curve, either the mean or median may be used

2 That the chances are in favor of the existence of both initial and end spurts

3 That a curve that combines both speed and accuracy gives a better picture of the situation than one taking into account only one of these factors

4 That using the difference between points "a" and "b" as a measure of fatigue all six series give about the same results

5. That the same general conclusions would have been arrived at from any one of the six series

6 That fatigue, as measured in this experiment, depends primarily on age, then on ability in the function used, then intelligence (This statement is to be interpreted very conservatively and cautiously because of the low correlations and high probable errors)

REFERENCES

1 BILLS, A G Mental work *Psychol Bull*, 1929, **26**, 499-526.

2 GARTH, T R Mental fatigue during continuous exercise of a single function *Arch. Psychol*, 1918, No 41. Pp ix+87.

3 GRAF, O. Ueber lohnendste Arbeitspausen bei geistiger Arbeit *Kraepelins psychol. Arbeiten*, 1925, 7, 548.

4. HOLLINGWORTH, H L, & POFFENBERGER, A T Applied psychology New York Appleton, 1923. Pp 431

5 REED, H B Fatigue and work curves from a ten-hour day in addition *J. Educ. Psychol*, 1924, **15**, 389-392.

6. WHIPPLE, G M The national intelligence tests *J Educ. Res*, 1921, 4, 15-31

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THE CORRESPONDENCE BETWEEN HANDEDNESS AND EYEDNESS IN YOUNG CHILDREN

RUTH UPDEGRAFF

The possible existence of a relationship between ocular dominance and handedness was suggested more than twenty years ago Parson (3) has held the most extreme point of view, claiming a direct and positive relationship More recently, data contributed by Miles (2) in studying left-handed adults and children of school age, and by Travis (4) and Jasper (1) in comparative studies of normal speakers and stutterers point to a possible although not so invariable a relationship

As a result of two recent studies (5, 6) of ocular dominance and unimanual handedness, information is available concerning preschool children Seventy-four children, two to six years old, attending the preschool laboratories of the Iowa Child Welfare Research Station received tests for ocular dominance and handedness For ocular dominance an adaptation of the Miles A-B-C Vision Test, of proved reliability with young children, was used The handedness test was one devised by the author, its validity and reliability for testing preferential handedness have been proved. The handedness of 37 of these children was also observed by a controlled and reliable method.

By test, the children were grouped as to eyedness and handedness as follows

Left-eyed	19	Left-handed	8
Right-eyed	41	Right-handed	63
Amphiocular and doubtful cases	14	Ambidextrous and doubtful cases	3

Considering individual correspondence of dominant eye and hand, classifications are:

Right-handed and right-eyed	38
Right-handed and left-eyed	15
Left-handed and left-eyed	4
Left-handed and right-eyed	2
No apparent dominance in either	2
Doubtful	13

The relationships, when placed on a percentage basis, are shown in Figure 1

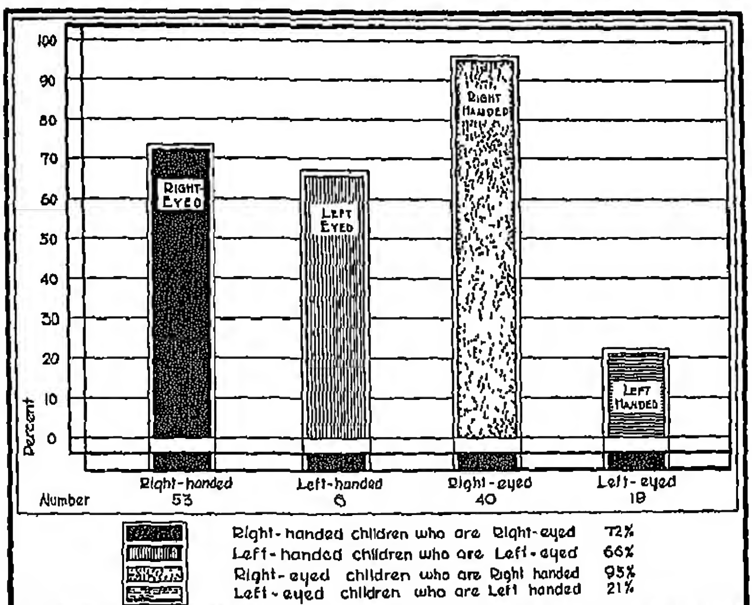

FIGURE 1

Relative Frequency of Types of Eyedness in Right- and Left-Handed Children, and Types of Handedness in Right- and Left-Eyed Children

A right-eyed child is evidently more apt to be right-handed than a left-eyed child to be left-handed Right- or left-handed children have somewhat more chance of being respectively right- and left-handed than otherwise, correspondence is found in approximately 75% of the cases These figures for the right hand agree substantially with those of other investigators working with older subjects Miles (2) states that "the large majority" of right-handed are also right-eyed. Travis (4) found 73% of right-handed normal speakers were right-eyed, Jasper (1) found 70 to 75% and reported an unpublished study by Metfessel in which the percentage was 71 The proportion of left-handed children found in the present study to be also left-eyed is slightly higher than that of other investigators This may be due to the limited number of left-handed children here reported Approximately half of Miles's left-handed group was left-eyed; Metfessel and Jasper reported similar results

The meaning of these facts which indicate correspondence in some cases and not in others can only be suggested. There is the possibility that even at these early ages "native handedness," if it exists, has been changed through training in some cases. A shift in ocular dominance, due to unequal acuity in the two eyes, is only a possibility, Jasper stated a 31% more than chance correspondence between indication of the best eye and eye preference in unilateral sighting, but further information is needed on this point. Possibly the concept of unilaterality as varying in degree and of that degree expressed in terms of different manifestations of dominance, of which handedness and eyedness are only two, is the most plausible hypothesis at present

References

1 Jasper, H H A laboratory study of diagnostic indices of bilateral neuro-muscular organization in stutterers and normal speakers *Psychol Monog*, 1932, **43**, No 1 (*Univ. Iowa Stud Psychol.*, No. 15), 72-174

2 Miles, W Ocular dominance demonstrated by unconscious sighting. *J. Exper Psychol.*, 1929, **12**, 113-126

3 Parson, B S Left-handedness New York Macmillan, 1924 Pp 184.

4 Travis, L. E A comparative study of the performances of stutterers and normal speakers in mirror tracing *Psychol Monog*, 1928, **39**, No 2 (*Univ. Iowa Stud Psychol.*, No 12), 45-50.

5 Updegraff, R Ocular dominance in young children *J Exper Psychol*, 1932, **15**, 758-766.

6 ——— Preferential handedness in young children. *J Exper Educ*, 1932, **1**, 134-139.

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DIFFERENTIAL SUSCEPTIBILITY OF CHILDREN AND ADULTS TO STANDARD ILLUSIONS

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I THE PROBLEM AND BACKGROUND

Gestalt theorists have made a good deal of the familiar fact that children's perceptions differ in characteristic ways from those of mature life Stern (4, pp 162-163) is responsible for what are probably the classic observations on this point He states that one remarkable capacity which young children possess is the independence of figure and spatial position as revealed in their ability to look at picture-books upside down without being in the least disturbed. The older the child becomes, the more it loses this indifference to the absolute spatial position of the visual object. But even at the beginning of the school period many children copy the letters given them in all possible positions, producing mirror-writing or inversions; certain youngsters read mirror-writing at first just as well as ordinary writing, a task which adults find unusually difficult. Stern believes that the recognition of displaced pictures can be understood only if we assume that the perception of the form and the perception of the position (i e, its relation to the observer) are two distinct psychic functions, the second being developed through a slower learning process

Koffka (2, p. 293) apparently accepts this interpretation, adding that in the course of time right and left, above and below, become characteristic properties of the different members of the configuration, and consequently of the total form, so that for adult perception the absolute orientation of the figure is a very powerful factor This view leads him to suppose that the well-known overestimation of a square standing on a point, as compared with one of the same size lying on its side, would not exist for children whose forms are as yet independent of spatial positions

Sander (3, pp 39-42), representing the Leipzig school of configurationism, has designed an interesting parallelogram figure with diagonals apparently of different size, and reports that the illusory effect obtained with this is maximal with children and *decreases* with increasing age He offers much the same explanation of the varying appearance of a square on its base and on a tip that Koffka does, claiming that in the developed consciousness the verticals and horizontals dominate in the total visual field Consequently, the diagonal distances in the square balanced upon a point are especially emphasized and, since they are greater than the sides, the square is phenomenally larger In the child, however, this difference in emphasis is absent and one would therefore expect the difference in magnitude to disappear also

The present writers felt that the problem here raised involved more than the correct explanation of a specific illusion If the child's perception of

space is really markedly different from the adult's, then not just one or two isolated illusions should exhibit this fact but most of the standard illusions should behave in opposed ways The available literature on this point consists largely of curious qualitative descriptions with occasional warnings that individual differences among children of the same age are pronounced Cramaussel (1), who examined 82 children aged four to seven years, states that the Muller-Lyer illusion and a few like situations show that the mechanisms relating to these phenomena are already apparent in the child, but the manifestation of them is uncertain and *increases* with age. It is clear that some psychologists contend that certain illusions become more pronounced with age while others maintain that a few effects diminish with years. The need for more precise statistical data on this question led the authors to inquire into the quantitative differences between adults' and children's responses to several commonly used laboratory illusions

II Procedure

The illusions which were finally chosen for extended testing are reproduced in Figure 1. These eight forms (or pairs) were drawn in heavy black India ink on sheets of stiff paper, 12 x 17 inches in size, which was large enough to be seen without effort by all pupils in an ordinary schoolroom In each instance, the lines or areas to be judged were drawn mathematically equal and labelled "A" and "B" to facilitate comparison for the observer and to simplify the process of recording

The subjects of the experiment consisted of pupils in the grade schools at State College, Pa, and undergraduates at the Pennsylvania State College, divided as follows:

Class	*Number of subjects*
First grade	31
Second grade	39
Fifth grade	39
Sixth grade	63
College Juniors	75

All the data reported below were gathered by means of group experiments in which each member received a record sheet containing at the left margin the numbers one to eight The subjects were told that the experimenter wanted to know how accurately they could estimate sizes and distances, and were instructed to mark on the sheet the letter "A" or "B," corresponding to whichever line or area appeared longer or larger to them Specific directions were given to *judge according to first impression* only If they could not tell them apart no mark was to be made The figures were exposed manually for about 10 seconds each with a longer pause between presentations

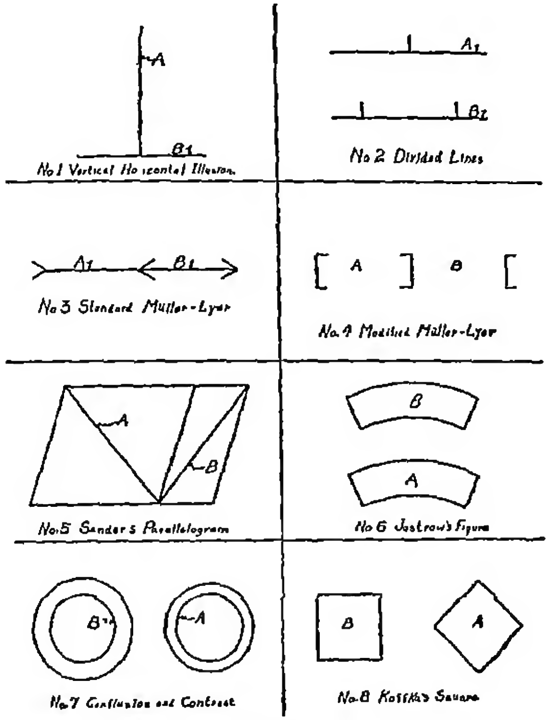

FIGURE 1

The above procedure ran very smoothly with the college and grammar-grade groups, but the novelty of the situation for the primary children made it wise to test them with only the Sander parallelogram (Illusion No. 5) and Koffka's square (Illusion No. 8), both figures of especial and crucial interest to configurationist theory. No difficulties were encountered which would throw doubt upon the accuracy of their responses, since the entire event took place under the guise of a game.

III. Results

The tabulation of the individual records was a simple clerical task. The percentage of each age group which saw the illusory effect in the normal and anticipated direction appears in Table 1 under the caption "positive", the difference between this value and 100 (labelled "negative") indicates the percentage who failed to respond in the expected manner.

TABLE 1

DIFFERENCES IN THE PERCENTAGE OF ADULTS AND CHILDREN OF VARIOUS AGES WHO REACT NORMALLY TO COMMON ILLUSIONS

Illusion No	75 Adults		Children in Grades V & VI combined (102)		Children in Grades I & II Combined (70)	
	Positive %	Negative %	Positive %	Negative %	Positive %	Negative %
1	95.76	4 24	98 9	1 1		
2	71 42	28 58	59 80	40.20		
3	94.28	7 72	100	0.		
4	77 55	22 45	48.72	51.28		
5	95 64	4 34	93 39	6 61	97 79	2 31
6	79 09	20 91	82.79	17.21		
7	74.99	25.01	82 80	17.20		
8	78 77	21 33	64 12	35 88	74 17	25 83

These raw percentages, of course, have little meaning apart from a knowledge of the reliability of the differences between them. The use of the familiar formula

$$\sigma_{p_1-p_2} = \sqrt{\frac{p_1 q_1}{n_1} + \frac{p_2 q_2}{n_2}}$$

where p_1 = percentage of adults reacting positively
q_1 = percentage of adults reacting negatively
n_1 = number of adults
and p_2 = percentage of children reacting positively
q_2 = percentage of children reacting negatively
n_2 = number of children

enables one to make the computations leading to Table 2 The columns are all self-explanatory except that where the "differences" favor the children a minus sign has been prefixed.

IV CONCLUSIONS

The interpretation of these figures is not as straightforward as one could desire, but a high specificity of effect is indicated throughout In exactly one-half the cases children are more susceptible to certain kinds of illusions than adults, and vice versa Perhaps it is no longer correct to consider youngsters of 10-11 years as children in the psychological sense, in which event the data for the 6-7-year-old children acquire more significance. The chances appear to be that such younger school children will be more susceptible to the Sander parallelogram illusion in three cases out of four,

TABLE 2

RELIABILITIES OF THE DIFFERENCES BETWEEN THE PERCENTAGES OF ADULTS AND CHILDREN IN RESPONDING POSITIVELY TO STANDARD ILLUSIONS

Illusion No	σ_{diff}	Difference	Critical ratio	Chances in 100 against reversal of difference
A. Grades V and VI				
Children more susceptible to No 1	2 55	— 3 14	—1 23	89
Adults " " " " 2	7 12	11 62	1 63	94
Children " " " " 3	2 68	— 5 72	—2 3	98
Adults " " " " 4	6 9	28.83	4 17	100
Adults " " " " 5	3.4	2 25	66	74
Children " " " " 6	6 00	— 3 70	— 61	73
Children " " " " 7	6.24	— 7.81	—1 25	89
Adults " " " " 8	6.7	4 65	.69	76
B Grades I and II				
Children more susceptible to No 5	2 96	— 2 15	73	77
Adults more susceptible to No 8	7 05	4 60	.65	74

while precisely the reverse holds for Koffka's squares To this extent, at least, the present study is a confirmation of these authors' claims.

Strangely enough, however, the primary pupils and the adults resemble each other more closely in these respects than either of them resembles the grammar-grade group—a fact which certainly militates against any simple conclusion concerning increase or decrease of illusory effect with age! None of the differences between the percentages for each group is conventionally reliable with the exception of the modified Muller-Lyer pattern, something which is also very hard to explain Indeed, Cramaussel's claim that the ordinary Muller-Lyer illusion increases with age is utterly opposed by those findings The suspicion which seems warranted is that individual differences in the population far exceed the influences of chronological age as such Certainly it is all but impossible to find any common characteristics in those illusions which are greater in children or in those wherein adults "excel," such as seemingly should be present if children's figural perceptions are really independent of spatial position as certain authorities maintain.

It is possible, of course, that sharper distinctions might have been revealed had still younger children of nursery-school age been studied However, group testing of the type described above is difficult to apply with subjects of such tender years, and it is further questionable if the results of individual experimentation can always be legitimately compared with those obtained by mass procedures. At any rate, grave doubt should be thrown upon the oft-repeated, but seldom verified, assertion of the peculiar nature of children's phenomenal experiences However qualitatively different some children's perceptual responses may be, their behavior when considered as a group is not notably, if at all, distinct from that of adults

REFERENCES

1 CRAMAUSSEL, E Expériences au jardin d'enfants *J de psychol*, 1927, 24, 701-718

2 KOFFKA, K Growth of the mind an introduction to child psychology. (Trans. by R M. Ogden) New York Harcourt, Brace, London Kegan Paul, 1924. Pp xvi+383 (2nd ed, 1928 Pp xix+427)

3 SANDER, F Experimentelle Ergebnisse der Gestaltpsychologie *Ber u d X Kong f. exper Psychol., Jena*, 1928

4 STERN, W. Psychologie der fruhen Kindheit, bis zum sechsten Lebensjahre (6th ed) Leipzig Quelle u Meyer, 1930 Pp xiv+539

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BOOKS

JOHN A LARSON, in collaboration with George W Haney and Leonarde Keeler *Lying and Its Detection A Study of Deception and Deception Tests.* Chicago. Univ. Chicago Press, 1932. Pp xxii+463

The present volume, one of the latest of the *Behavior Research Fund Monographs*, is a thoroughly systematic treatment of the topic of deception as well as a review of the attempts, scientific and other, to detect the presence of deceptive efforts. While no more than a third of the book is given over to description of the author's own experiments on he detection by the blood-pressure method, the balance of the book provides a broad background of fact and opinion that does the service of bringing Larson's work into historical perspective

Quoting at great length from a literature apparently too greatly burdened with guesswork and hearsay and too little concerned with scientifically observable phenomena, the author shows the present status of the problem of lying Many approaches are represented Not only are defining and classificatory schemes discussed but there are considered such topics as lying in children, sex differences in lying, pathological lying, the physical concomitants of the state of guilt, and the prevalence of lying Ancient methods concerned with the determination of innocence or guilt are described and these procedures are traced through a round of group mores and local customs to the contemporary "third degree" methods of the police examining room From the primitive solutions by combat, ordeals of various kinds, and torture, to modern police methods and our present judge and jury system is not a far cry when examined from the viewpoint of the general cultural patterns involved

Larson's own work is given its immediate setting by relating it to other efforts involving modern scientific methods The pulse-rate studies of Lombroso, the now classic experiments on reaction-times and word associations, and the use of the blood-pressure method by Marston, Benussi, and Burtt are given detailed treatment. The negative evidence coming out of the somewhat more general studies of blood pressure as an emotional indicator, particularly those of Landis and Gullette and those of Landis, receives only cursory mention Brunswick's significant work is entirely overlooked An entire chapter is devoted to the tragicomedy of scopolamin, the "truth serum," and Dr House's espousal of it Brief consideration is allotted to other contemporary efforts, notably various questionnaires and inventories, psychogalvanic studies, and work with the ergograph

The experiments of the author and his associates are described in the last major division of the book (Part IV) and have to do with extensive

work with the use of the cardio-pneumo-psychograph, popularly called the "lie detector" Neither name is apt and both savor of hocus-pocus. The instruments, the records of which serve as the bases for Larson's conclusions, are simply the common form of pneumograph together with a modified Erlanger sphygmomanometer

Unlike a host of other workers who have preceded him Dr Larson has turned to real life situations to get his material for study. His experiments are performed on criminals, the deception tests being made chiefly in the penitentiary and the police examining room It is demonstrated by case studies that notable changes occur in both of the bodily functions measured whenever the subject under examination departs from the truth in answering questions of the variety ordinarily employed in police quizzes Blood-pressure changes are of particular diagnostic value In support of his conclusions Larson cites a large number of cases investigated by him and his colleagues in which predictions with respect to guilt or innocence were borne out by the actual findings. No sensational claims as to the value of the method as a lie detector are made, however There occur cases in which an individual may lie yet show no disturbances measured by the instruments, there are instances in which innocent people through fear of the test situation give positive records; there are individuals, again innocent of crime, who display "guilt complexes" quite habitually. In spite of these difficulties Larson feels that the device is valuable in the beginning stages of a police investigation in that it is likely to eliminate from further consideration clearly innocent suspects He is of the opinion that the Lindbergh case would have proven the efficacy of the procedure

In no case should the results of such a test be introduced as court evidence since full cooperation of the subject is necessary before any reliability accrues to the results. The evaluation given by the author, whose training and experience allow him to speak both for the psychologist and the police official, stands in marked contrast to the usual claims for the lie detector encountered in sensational newspaper stories

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Books Received

ABELSON, H H The art of educational research. its problems and procedures Yonkers, N Y World Book Co, 1933 Pp. xii+332 $2.00.

BORING, E G The physical dimensions of consciousness New York & London Century, 1933 Pp xii+251. $2 25

BOYNTON, P L Intelligence. its manifestations and measurement. New York & London Appleton, 1933. Pp xii+466 $2.50

BREED, F S Classroom organization and management. Yonkers, N Y.: World Book Co, 1933 Pp xvi+472

GALT, W Phyloanalysis. a study in group or phyletic method of behaviour-analysis (*Psyche Miniatures*, Gen Ser, No 49) London. Kegan Paul, 1933 Pp 151

GILBERT, L C An experimental investigation of eye movements in learning to spell words *Psychol Monog.*, 1932, 43, No. 196. Pp viii+81

HAGMAN, E P The companionships of preschool children. *Univ. Iowa Stud. Stud Child Welfare,* 1933, 7, No 4 (New Ser, No 255). Pp. 69. Paper, $1.00, cloth, $1.35

KANDEL, I. L Comparative education Boston Houghton Mifflin, 1933 Pp xxvi+922 $4.00.

KLÜVER, H. Behavior mechanisms in monkeys (*Behav. Res Fund Monog*) Chicago: Univ Chicago Press, 1933 Pp xviii+387

KOLOSVARY, GABOR (Klososváry, Gabriel von) Magyarország kaszáspókjai (Die weberknechte Ungarns) Budapest: "Studium" Kiadása, 1929. Pp 112+11.

McDOUGALL, W The energies of men a study of the fundamentals of dynamic psychology New York Scribner's, 1932 Pp xii+395 $2 00

MERRY, R V. The education of visually handicapped children (*Harvard Stud Educ.*, Vol 19) Cambridge, Mass. Harvard Univ Press; London: Oxford Univ Press, 1933 Pp. xiv+243 $2 50.

MORRISON, H C The evolving school Cambridge, Mass. Harvard Univ. Press, 1933 Pp. 62

NORSWORTHY, N, & WHITLEY, M T The psychology of childhood. (Rev ed.) New York Macmillan, 1933. Pp xviii+515. $1 80

RICHMOND, W V The adolescent boy New York: Farrar & Rinehart, 1933 Pp. xvi+233 $2 50

ROBINSON, F P The rôle of eye movements in reading with an evaluation of techniques for their improvement *Univ. Iowa Stud. Ser. on Aims & Prog. Res.*, 1933, No 39 (New Ser, No 252) Pp 52. $ 50

SCOE, H. F Bladder control in infancy and early childhood *Univ. Iowa Stud Stud Child Welfare,* 1933, 5, No 4 (New Ser, No 253). Pp 83 Paper, $1 00, cloth, $1.35

SEASHORE, C. E Approaches to the science of music and speech *Univ. Iowa Stud Ser on Aims & Prog Res*, 933, No 41 (New Ser., No 258) Pp. 15

SELZER, C A Lateral dominance and visual fusion their application to difficulties in reading, writing, spelling, and speech (*Harvard Monog Educ.*, No 12) Cambridge, Mass Harvard Univ Press, 1933 Pp xvi+119 $1.00

SHERMAN, M, & HENRY, T R Hollow folk New York Crowell, 1933 Pp viii+215. $2 00

TUMLIRZ, O Jugendpsychologie der Gegenwart (*Phil. Forschungsver*, No 7.) Berlin Junker & Dunnhaupt, 1933 Pp 97

WAGONER, L C The development of learning in young children New York: McGraw-Hill, 1933. Pp. xiv+322 $2.50

WILLIAMS, H M., SIEVERS, C H, & HATTWICK, M S. The measurement of musical development *Univ. Iowa Stud Stud Child Welfare*, 1933, **7**, No 1 (New Ser, No 243). Pp. 191

SUBJECT INDEX

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